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BUSINESS SESSION

PROCEEDINGS

The object of this Association is the advancement of knowledge pertaining to the scientific and economic location, construction, operation and maintenance of railways. Its action is not binding upon its members.

TUESDAY, MARCH 10, 1931

MORNING SESSION

The Thirty-Second Annual Convention of the American Railway Engineering Association was called to order in the Grand Ball Room of the Palmer House, Chicago, by the President, Mr. G. D. Brooke, Vice-President and General Manager, Chesapeake & Ohio Railway.

The President:—The meeting will please come to order.

This is the Thirty-Second Annual Convention of the American Railway Engineering Association and the Annual Meeting of the Maintenance and Construction Section of Division IV, Engineering, American Railway Association.

It is very gratifying to see such a large number of members in their seats, and I extend to you all a cordial welcome.

The first order of business is the approval of the Minutes of the last meeting. They have been delivered to all of the members in printed form, and unless there is some objection the reading will be dispensed with. There being no objection, they will not be read, but will be adopted as they stand. It is so ordered.

The next is the President's address.

ADDRESS OF PRESIDENT G. D. BROOKE

I count it a cherished privilege to address this Association as its President.

As I have been able to observe, one of the outstanding characteristics and one of the greatest assets of the Association is the pride of membership of the individual member and his will to advance its objectives, its welfare and prestige, through personal effort. It would be surprising then if there did not pervade this assemblage a keen interest in the Association's affairs and a desire that some outline of their current status be given.

ASSOCIATION AFFAIRS

Our nation, in common with the whole civilized world, has for some sixteen months been struggling acutely with the forces of economic readjustment. The problems which the railroads have faced have been made particularly difficult by the strong competition of other unregulated and subsidized forms of transportation. The methods required under such circumstances are entirely different from those of the several preceding years. From that of the moving of an increasing or well sustained traffic the problem has reverted to one of adjusting operations to meet the impelling requirements of much reduced revenues, but, nevertheless, to provide a very high character of transportation. Stern necessity has dictated measures which, while extremely

distasteful to the railway officer, were none the less clearly in the path of his duty.

In this situation the American Railway Association deemed it wise to curtail its activities for the year 1931 as far as practicable, and many of its Divisions and Sections have decided not to hold the usual annual meetings, or to shorten them very materially, eliminating so far as might be the annual dinners and other features of the nature of entertainment.

Your Association, as you know, forms the Maintenance and Construction Section of the Engineering Division of the American Railway Association. As such it necessarily and logically was faced with the problem of determining the scope of the annual meeting. In considering this important question, involving as it did a departure from the practice of many years standing, your Board did not fail to give due weight to the character of your organization, in that it is primarily an association of individuals, nor to the essential part which the annual convention plays in the Association's work. But for reasons similar to those which impel the maintenance officer who, alive to the situation, is with courage, resourcefulness and adaptability, meeting the current problems of his own railroad, it seemed obvious that the best interests of your Association would lie in conforming to the spirit of the time by reducing the duration of the convention to two days and omitting the annual dinner, but at the same time endeavoring to so plan the program as to permit full discussion of the committee reports and thorough consideration of all of the business of the convention. It is with a feeling of confident assurance that I bespeak your hearty cooperation toward the accomplishment of this important end.

Doubtless in the minds of some of you there has arisen the question of whether a precedent is being set which will influence future conventions. So far as I am able to judge, there is no good reason why the normal plan of a three-day convention with the annual dinner should not be resumed after this year. The consideration of committee reports and other business are ample to justify three working days under normal conditions. The annual dinner, with the addresses by prominent speakers and the opportunities for social contacts, is an occasion not only of pleasure but of real profit. It adds much to the spirit of the convention and undoubtedly attracts a number of members who otherwise would not attend. Regrettable, therefore, as are the circumstances leading to the shorter convention at this time, we should dismiss from our minds any misgivings as to the future and any ideas that there is any attempt or intention to change the well established customs of the Association as to the convention.

For several years past the expenses of the Association have been running uncomfortably close to receipts, and it has been increasingly evident that something must be done to meet this unhealthy condition. Means of increasing the Association's revenues have been considered carefully by the Finance Committee and your Directors, but, in the present situation at least, found not practicable. It remained then to look to a reduction of expenses for relief.

The publications have progressively grown to be voluminous and their cost forms a large part of the total operating expense. During the past year the Committee on Publications very ably assailed the problem of decreasing this important item of expense. By reducing the volume of matter for publication in the Bulletins and Proceedings and by negotiating a more favorable contract for printing and binding, it has met the needs of the situation in an

admirable way. It was successful in working out and, with the usual able and hearty assistance of the Standing and Special Committees, in making effective a plan whereby the volume of these publications will be reduced some 30 per cent or more. This plan contemplates omitting from the reports non-essential material and that of a temporary nature, and it is believed that the utility and value of the committee reports will be increased rather than reduced, and that the expenses of the Association will be brought comfortably within its revenues. During the year just ended receipts exceeded expenditures by $1869, and the Association's finances now appear to be upon a sound basis. This is another illustration of the splendid work and the fine spirit of cooperation on the part of its Committees which has brought your Association to its recognized high position in the railway engineering world.

It is a great pleasure to inform you that the American Railway Association at its meeting in New York on November 19, 1930, authorized appropriations which enabled the Rail Committee to join with the Rail Manufacturers' Committee in an extended research to determine the causes of transverse fissures and other defects in steel rails. This research, which will be carried on by the University of Illinois under the supervision of the committees named, will extend over a period of five years and will cost $250,000. The funds will be provided in equal amounts by the American Railway Association and the Rail Manufacturers. The Chairman of the Rail Committee will doubtless comment more in detail upon this important development. May I point out, though, that this is an outstanding example of the promotion of the ends of your Association made possible through its function as the Maintenance and Construction Section of the American Railway Association.

The membership of your Association as of March 1, 1931, was 2791, which is 65 less than that reported as of March 1, 1930. During the year there have been additions of 145 to the membership and losses of 210, including those from deaths, 36, resignations, 55, and dropped, 119. Some of the resignations and the unusually large number of members dropped were undoubtedly a result of the current business situation. The Board Committee on Membership is developing plans for a membership campaign during 1931 which it is expected will off-set the losses of the past year. The support and individual interest of the membership are counted upon as an important factor in this effort.

It is with a sense of deep regret that the passing of 36 valued members of the Association is recorded, including four Charter Members, six railway Executives, five Chief Engineers, one scientist, and three operating officers of railways.

Notwithstanding the considerably reduced volume of matter appearing in the Bulletins, there being 702 pages in the reports submitted as against 1670 pages in 1930, a careful perusal of them will indicate that the work of the Standing and Special Committees is of the usual high order and that the reports, soon to be considered and acted upon, comprise another important chapter in American railway engineering practice.

The program of work and list of personnel of the Standing and Special Committees for the current year were issued on January 1st. It will be a distinct advantage to the committees if this information can be promulgated in future about the time of the filing of the committee reports, or at least by the end of November.

Two additional special committees have been authorized by the Board of Direction to deal with subjects of particular interest to maintenance officers and of economic importance to the railways. These are the Special Committee on Maintenance of Way Work Equipment, organized early last year, and the Special Committee on Waterproofing, more recently authorized.

One amendment to the Constitution has been adopted during the year. It deals with requirements for membership and provides that graduation from an engineering school of recognized standing be considered as the equivalent of three years of active practice, and that satisfactory completion of each year of work in such a school without graduation be considered as equivalent of one-half year of actual practice.

Two members of the Association have been honored by appointment as Reporters for the International Railway Congress to be held at Cairo, Egypt, in 1933. Mr. Sidney Withington, Electrical Engineer, New York, New Haven and Hartford, will report on "Electrification of railways from an economical point of view; selection of sites for generating stations, choice of the kind of current; safety precautions, etc.," and Mr. F. M. Thomson, District Engineer, Missouri–Kansas–Texas Lines, will report on "The use of mechanical appliances in the permanent way maintenance and in track relaying."

The reports of the Secretary and Treasurer will set forth in more detail the various affairs and activities of the Association.

THE ENGINEER AS A RAILWAY OPERATING OFFICER

When a speaker is given such freedom in the choice of his subject-matter as is granted the President of your Association by the by-laws, they imposing upon him simply the obligation of making an address, it is but natural that he should endeavor to select some subject which is of more than casual interest to his audience, particularly when that subject is close to his heart. Finding myself in so favorable a situation, and moreover, because the ideas which I shall endeavor to convey are for the most part not at all original ideas of mine, but have been gained through privileged association with railway leaders of such outstanding ability as to give to their views the weight of acknowledged authority, I make bold to undertake some brief remarks regarding the Engineer as a railway operating officer. And here let me venture the opinion that there are railway officers, who have neither enjoyed the advantages of an engineering education at college nor as rodman, chainman, or in other capacity, served an apprenticeship in an engineering organization, but nevertheless have through observation, through experience, through self-education, through intuitive good judgment, absorbed such a knowledge of engineering principles and practices as to make them truly Engineers—although they themselves may never have thought of themselves in this way.

You are all familiar with the great extent to which engineering officers report to and are successfully directed by operating officers who are not Engineers, or who at least are not generally recognized as such. You are likewise cognizant of the increasing extent to which operating officers are being drawn from the engineering ranks and the success with which they are meeting their problems as operating officers. It is not upon these that I wish to dwell, but rather upon the problems and opportunities of the young Engineer who sets himself to the task of gaining such knowledge of and familiarity with

operating conditions and practices as to best qualify him for the assumption of positions in the lower operating ranks, and thus place himself in line to take advantage of the larger and more varied opportunities which such a course holds out.

Your Association and the National Engineering Societies place high estimates upon experience as a factor in determining engineering knowledge and ability, as is evidenced in their requirements for membership, and of their measures of the value in years of experience of graduation from and attendance at schools of recognized standing. This is mentioned simply to suggest some concrete idea of and to impress upon you the advantage to the prospective railway officer which experience in any branch or department of railway work gives in competing for advancement within such department with those not having such experience. Conversely, it shows the necessity of overcoming the deficiencies resulting from the lack of such experience in order that one might be successful in entering the official ranks of that department.

Besides inherent strength of mind and of body, the chief assets of the man who rises through the ranks to official position, are confidence in himself, a knowledge of practical psychology—so often comprehended in the expression "He understands human nature"—the ability to adapt to his own use the successful methods of others, and the power of concentration upon his specific problems.

Self-confidence is instilled by a familiarity with the details, a thorough ground-work in the activities, of the enterprise to be undertaken; such as is acquired by the youth who faced with the problem of earning a livelihood starts in at the bottom as a messenger boy, or call boy, and gradually works up through the various steps, of necessity stopping long enough in each to thoroughly learn it, to a supervisory position, such, let us say, as that of an assistant trainmaster. In such an experience he not only masters the details of his own immediate several jobs, but he gains a useful knowledge of operating rules and many other phases of railroad work. He soon picks up the important features of the working agreements with the several brotherhoods. He gradually absorbs a vocabulary of terms pertaining to locomotives, cars, tracks and signals, and an understanding of something of their significance. Waybills and bills of lading fall within his purview; he becomes acquainted with the book of operating rules, learns of the rights of trains, of "19" orders, and of positive and permissive blocks. He makes friends and rides around with the yard engine crews, and anon he can put in a fire himself and eventually handle the locomotive. Moreover, he learns to stand off the shifty brakeman who tries to beat the extra list or to lay off a trip to go fishing when men are scarce. He knows how to handle the hard-boiled yard foreman who tries to evade verbal instructions transmitted through him from the yardmaster. He humors one man, tries his powers of persuasion upon another, and coldly puts it up to the third to come across or go and see the boss. He gets the point of view of the men, as well as that of the "Company"; learns their method of thought and views and their attitude towards their work, their rights, discipline, brotherhood relations, and many co-related subjects. He also acquires the knack of successfully meeting the wishes of his superior. A conversation between the secretaries to two Federal Managers, overheard one day during the World War and Federal Control, on how to handle their respective bosses would make excellent reading if it could be reproduced.

Parenthetically, one of these boys was a trainmaster a few months later.

This is the atmosphere in which the "knowledge of human nature" is born; this is the experience which begets confidence in one's self, which grows and ripens into fruitful achievement.

Now how can the young railway Engineer make up for his lack of such experience; how can he gain the knowledge, the self-confidence, the practical intuition with which the grown up call boy is equipped, and which is necessary if he is to qualify for the lower ranks of operating supervisory positions early enough in life to take advantage of the opportunities which they offer.

Obviously by simply grasping the many opportunities which surround him. He has already formed habits of study which will enable him to readily master the rules, instructions, and other information which is available in written or printed form. He should read and study everything he can lay his hands upon pertaining to the details of railway operation and to every phase of the activities of his own railway. He should make friends with those who can supply him the information which he lacks, and should ever be ready to help them by giving in return information which they desire and he possesses. Weekly trips to the yard office, occasional visits to the chief dispatcher's clerk, on which work train assignments or some other matter of mutual business can be made the opening subject of conversation, should enable him to establish relations under which exchanges of information can be readily made. A friendly interest in the duties of an acquaintance who works a night trick, with perhaps lending a hand to help out during the rush hour, will lay the ground for ready responses to questions designed to develop desired information.

He should cultivate habits of observation. It is difficult to say which is the most unfortunate, the individual who goes through life with his eyes open but sees little or nothing, or the one who wants information but is afraid to ask questions, preferring to remain ignorant rather than to be thought so.

A healthful curiosity will do no harm and the satisfying of it through study and the tactful questioning of friends and associates will be distinctly beneficial. He should at every opportunity sit in on investigations of train accidents, infractions of the rules, and other matters involving discipline, and should lose no opportunity to inform himself as to the methods and practices in dealing with employees' committees. All of this should be done with the idea of qualifying himself for a supervisory job in the Operating Department. But how will he break into operating work and get the opportunity to show what he can do. That is indeed an important problem.

First of all he should maneuver himself into division maintenance of way work, so as to be in the closest possible contact with actual operations. Then he must make a reputation for himself in the engineering position which he holds. This requires that he be industrious, willing to work long hours, and irregular hours upon occasion; that he be reliable and resourceful, tactful and cheerful, able to get along well with associates and to handle men; that he have good judgment and a reasonable ambition and be willing to assume responsibility. His aim should be to make of himself the best man in the organization for the job which he fills and the best qualified for promotion. He should realize that the greatest usefulness and success as a Maintenance Engineer can be achieved by sensing and meeting the management's point of view. He may occasionally find it necessary to submerge idealism, and even good practice to the needs of the occasion. Sooner or later he will learn from

experience that it is so much better to keep the situation well in hand, to plan and modify his program to meet current resources than to go ahead running into over-expenditures and be forced into drastic fluctuations of his organization later on. As to expenditures in general, he can find no better criterion for his judgment than to honestly determine for himself what he would do if the property were his, if the funds to be spent were his very own, and if he alone would reap the results.

Nor will there be lacking opportunities for demonstrating his knowledge of operating matters. Studies for improved facilities which depend for their justification upon savings in train operation form an excellent example. It will be particularly advantageous to develop the ability to write a good report. A neat, well planned report, which sets forth logically, clearly and concisely the essentials of the study, the conclusions and definite recommendations, is not only effective as a means of having meritorious recommendations carried out, but will serve to draw favorable attention to its author. Discussions with the division operating officers of yard plans, station and passing track layouts, signal locations and other features of the railroad which directly affect train movements may be mentioned. The very nature of the railroad organization will offer many occasions for showing his knowledge of operating practices, and of demonstrating his training and fitness to take a part in them when the opportunity is offered.

Having gained his second objective, he will doubtless soon have occasion to prove to a circle of perhaps skeptical onlookers that he is not out of place. A few months of going slow, of being sure of himself before undertaking changes in methods should suffice for this. He should be careful to avoid being led into immature decisions upon interpretations of train rules, current instructions, working agreements and such matters. He will best gain and hold the respect of the men he must supervise by being frank, and if he is uncertain on any question, saying so and suggesting that the subject requires some consideration and he had best take it under advisement for a few days. He should, of course, obtain the proper answer to the question without delay and satisfy those raising the inquiry.

He will find that when it comes to getting things done his official title means very little; that in the final analysis he must rely upon his own resourcefulness, his courage, and his strength of character, and that the degree of his success will be measured by his own ability. It will strengthen his position if he will assume full responsibility in requiring that instructions be carried out and in fulfilling the disagreeable duties in connection with discipline. It is an acknowledgment of weakness for an officer to say that the instructions are those of his superior rather than his own. He must learn to say "no" at the proper time and to stick to it. When employees are asking favors which cannot be granted and when dismissed men are seeking reinstatement, it is subversive to discipline and unfair to the men to string them along with the hope that their pleas will be granted. It is much better for them and for all concerned for such questions to be settled definitely, so that they can devote themselves to other things.

Experience will teach him that a large percentage of employees want to do right provided they are treated fairly and their rights respected; that it pays to be lenient with the man of generally good intent who makes a mistake and gets into trouble; but on the other hand, vicious and worthless individuals are

out of place in the railway organization and a disadvantage to other employees, as well as to the railway.

He must look to those features of operation which have the greatest influence upon cost—the train load, yard switching methods, keeping trains moving on the road. He will find that current operating matters must be handled very promptly—hot off the bat, so to speak. He should not forget his maintenance friends, but assist them with efficient work train service and in the many ways which will make their allotment go further in providing good roadway and track. As he must live with his associates of his own and adjoining division, he should cultivate a spirit of cooperative friendliness and avoid antagonism if at all possible.

Having found himself and mastered the details of his position, he will in due time be looking forward to getting ahead. Here he will find applicable the same formula which he relied upon as a maintenance man, and he should make it his purpose, first, to be the best officer of his class and rank; and second, the best material for promotion on the railway.

Here he should study and adapt to his own use the methods of recognized leaders with whom he has the privilege of coming in contact. He will doubtless observe that some men are born drivers, but most of them, if they will analyze themselves, are better leaders than drivers. Furthermore, the vast majority of men are not averse to being led but resent being driven. He will do well then to consider carefully the methods of the leader rather than of the driver. Such a leader weighs well the nature of his assignments, knows that they are practicable and workable, and in making them imparts impressions of such implicit confidence in their being carried out that the recipients feel challenged to use their utmost endeavor rather than disappoint him; he encourages freedom of thought and suggestion; he knows how to delegate important duties and authority to others, and to impart a high sense of responsibility to those assuming them. He works out a sound plan, makes sure that it is well and uniformly understood, places adequate checks upon performance and leaves the details in the hands of capable and trusted subordinates.

A most effective device of leadership is that which so suggests possible courses of action that they will be adopted and developed by those who must carry them out as their very own. The successful leader recognizes that he can gain little through pride in the origination of ideas or the authorship of plans. It is results he wants and since the burden of producing these results must fall upon the rank and file of the organization, to that organization belongs the credit for the achievement. He knows the great importance of maintaining a high *ésprit de corps,* that men take pride in being a part of an organization of high standing, and that they glory in upholding its records and its reputation; he recognizes that adequate rest and recreation, comfortable sleeping quarters, healthful surroundings, good working conditions, competent supervision, strict but fair discipline and appropriate recognition of meritorious action and results will bring out the best in the indivdual and foster such a spirit of teamwork and pride in the organization that high-class performance will be spontaneous. Fortunate indeed is the railway officer who masters the principles, the practice, and the spirit of such leadership (Applause).

American Railway Engineering Association

REPORT OF THE SECRETARY

March 1, 1931.

To the Members:

It is customary to render an accounting, annually, of our stewardship of the general affairs of your Association for the preceding year.

The appended report, it is believed, will show a year of essential progress and of increasing readiness on the part of the Association to meet the demands of the industry we serve, as well as to pursue the ideals historically fixed for our work.

The following is a condensed record of the American Railway Engineering Association's activities during the past year, under the guidance and direction of President G. D. Brooke, grouped under appropriate headings:

(I) **Committee-Work.**—General; Synopsis of Committee Reports; Cooperation with Other Organizations; Personnel of Committees by Railways; Exceptional Committee-Service Records.

(II) **Membership.**—Status of Membership as of March 1, 1931; Classification of Membership; Deceased Members; Geographical Distribution; Railway Executives Enrolled as Members; Railways Represented, Mileage and Members.

(III) **Publications.**—The Monthly Bulletin; Proceedings; Manual of Recommended Practice; Portfolio of Track-Work Plans, Designs and Specifications; Index of the Proceedings; Monographs.

(IV) **Finances.**—Financial Statements for Calendar Year 1930; Stresses in Railroad Track Fund; General Balance Sheet.

(V) **Miscellaneous.**—Laboratory Experiments of Imperfections in Rail Steel; Amendment to Constitution (relating to qualifications for membership); New Headquarters of the Association; "Reporters" for International Railway Congress Association; Acknowledgment.

Respectfully submitted,

E. H. Fritch,

Secretary.

(I) COMMITTEE-WORK

Committee-work is the chief instrument of the Association for the advancement of knowledge pertaining to the scientific and economic location, construction, maintenance and operation of railways. The results of its research in the Science of Railway Engineering and economic problems have been notable and outstanding in the past and promise to be so in the future.

In the early part of the past year, at the instance of President Brooke, an appeal was made to Committee Chairmen to eliminate from committee reports all material of a temporary nature or matter not of permanent value, in order that the Proceedings might not be burdened with data of this character. A review of the current reports will indicate that committees have cooperated whole-heartedly in this matter. It has been the aim of the Board of Direction to improve the *quality* of Association's work, rather than its quantity.

Below is given a brief synopsis of the salient points embodied in the reports presented for your approval:

Committee on Roadway.—The Committee is making a study of the question of preparing specifications for "Overhaul," which were formerly included in the Manual but were withdrawn. A number of changes in the chapter on Roadway in the Manual are submitted for approval, including a revision of Specifications for Concrete Fence Posts. A complete review and amplification of the subject of Roadbed Drainage, and its substitution for the corresponding material now in the Manual are submitted. A report of progress is presented on the subject "Influences affecting the life of fence wire and methods for preventing its corrosion." A further report is made on the subject of "Permanent Roadbed," supplementing the information heretofore presented. A report is offered on the topic, "Good grading practice," as information and to bring out discussion. "The use of highway crossing plank and substitutes" is discussed, and a test made on the Chicago, Milwaukee, St. Paul & Pacific is described. "Methods of roadway cross-sectioning calculations and measurements" are included in the report. The cause and prevention of heaving track due to frost action and maintenance methods while the effects of heaving are present are presented and discussed.

Committee on Ballast.—This Committee has been engaged in a revision of "Specifications for Prepared Gravel Ballast, including best method of testing, etc.," and is attacking the problem in two parts (1) consideration of requirements and methods of tests for grading and cleanness, and (2) consideration of methods of testing and requirements for hardness, abrasion and resistance to weathering. Revised "Specifications for Stone Ballast" are offered as a substitute for those now in the Manual. In answer to the question, "What is Ballasted Track?" the Committee offers the following answer: "Ballasted Track is track to which ballast has been applied in its proper relative position."

Committee on Ties.—A final report is made by the Committee on "anti-splitting devices" for cross-ties, supplemented by recommendations, specifications and drawings for such devices. From examinations made by the Committee as a whole and by individual members, it is the Committee's observation that not only did railroads more generally adhere to standard tie specifications during the past year, but that contractors also more generally rejected sub-standard ties, with the result that ties in existing stocks on the whole are nearer standard than they have ever been. Following its course of many years, the report contains up-to-date information as to substi-

tute ties, and a table giving data of such installations and results. The Committee submits a series of tables covering cross-ties laid in replacement on leading railroads of the United States and Canada, as of December 31, 1929. Methods and practices for proper seasoning of ties, with particular reference to increasing tie service life, are reported on. A valuable paper entitled "Study of the Life of Untreated Hardwood Ties and Creosoted Red Oak Ties, based on Tie Records of the Kansas City Southern Railway," by S. E. Shoup, a member of the Committee, is included in the report.

Committee on Rail.—Revisions of a number of forms now in the Manual are presented. Branding of tee rails, with a view towards standardization, with illustrations of typical brands, data to be given and order of arrangement, and also typical stamping recommended and complete list and design of letters and numerals, are presented for approval. Up-to-date information as to the operation of the Transverse Fissure car is offered. Rail failure statistics and also transverse fissure statistics are included in the report. The Committee has continued its study of the cause and prevention of rail batter and presents the results of such study. A comprehensive report is made on the tests of alloy and heat treated carbon steel rails, and the experiences of various railroads are given.

Committee on Track.—Revision of "Specifications for Steel Tie Plates" is proposed, also two additional sections. The Committee reaffirms its previous recommendation that the subject of super-elevation of the outer rail on curves be withdrawn, and gives its reasons for such recommendation. A substitute for the present recommendations in the Manual regarding temperature expansion for laying rails is presented. The Committee offers for approval plan for manganese steel one-piece guard rail on six ties, and two plans are submitted as information for Nos. 8 and 10 frogs of medium weight rails, rail-bound manganese steel, bolted rigid, spring rail and solid manganese steel. For the past three years the Committee has reported on methods of reducing rail wear on curves, with particular reference to lubricating the rail or wheel flanges; in the current report, the Committee offers some additional information, supplemented with conclusions. The cause and effect of brine drippings from refrigerator cars has been studied by the Committee for a number of years; in the present report the Committee again submits the recommendations proposed last year, to the effect that "Railroads require the maintenance of brine retaining apparatus on the meat-carrying or bunker type of cars in the best possible shape; that the Mechanical Division continue vigorously its efforts to perfect a design for the fruit and vegetable carrying car that will permit of installation and operation of brine retainers on this type car; that the effort on the part of the car companies and refrigerant manufacturers to find a refrigerant which will take the place of salt and ice, and eliminate entirely the making of brine, and consequently its damage, be encouraged by the American Railway Association and the individual roads; that in the meantime railroads continue the application to their structures of the protective agents mentioned and being tried on the various systems, and further to make tests of any additional agents which offer promising possibilities."

Committee on Buildings.—Tentative "Specifications for Concrete used in Railway Buildings" are offered for discussion with the view of submitting them at a later date for insertion in the Manual. Additional "Specifications for Buildings for Railway Purposes" are now submitted for approval, namely, Oil-Burning Equipment, Sheet Asphalt Pavements, and Asphalt Mastic Floors; a minor modification to the latter specification is proposed. Standardization of Metal Buildings and Parts is reported on, with a suggested specification. An exceptionally valuable report is submitted on the subject of the "Use of Welding in Buildings." This report includes definitions of welding terms, accompanied by illustrations; welding symbols; conventional welding symbols, and a partial list of structures in the United States built wholly or in part with welded joints. Another comprehensive report is that dealing with elevators, lifts and escalators.

Committee on Wooden Bridges and Trestles.—Progress is reported on the subject of Simplification of Grading Rules and Classification of Timber for Railway Uses; contact is being maintained with the Central Committee on Lumber Standards and the Forest Products Laboratory on this subject. In its report on Standardization and Simplification of Store Stock and Disposition of Material Reaching Obsolescence, the Committee points out that a more general use of the sizes and lengths shown on the plans for the Association's standards would result in simplification of manufacture of bridge timber, and this in turn would affect the simplification of storehouse stocks and permit of reduction of such stocks. Continuing its study of Overhead Wooden or Combination Wooden and Steel Highway Bridges, the Committee presents for consideration two typical plans for timber highway overhead bridges, one with concrete floor slab and the other with laminated timber floor and four suggested types of wearing surface.

Committee on Masonry.—Revised Specifications for Portland Cement are offered to replace those now in the current Manual. The Committee presents for discussion principles for the classification and design of reinforced concrete arches for railroad loadings; this data to be subsequently utilized as a basis for the preparation of recommended specifications for the design and construction of reinforced concrete arches for railroad loadings. Progress in the science and art of concrete manufacture is reported, and a tentative specification and test for high early strength Portland cement of the A.S.T.M. is submitted. A valuable report on Waterproofing and Dampproofing is presented. A comprehensive study on methods of repairing deteriorated concrete is embodied in the report.

Committee on Grade Crossings.—The Committee presents certain changes in the recommendations concerning standard automatic flashing light and wigwag crossing signals. Revised plans for highway crossing signs, prepared in collaboration with representatives of the Signal Section, are presented for approval. A report is submitted on the comparative merits of various types of grade crossing protection. An outline for the classification of highway grade crossings is presented as information; also, form of record of railroad and highway traffic over highway grade crossings. The Committee reports its conclusion that the principles heretofore adopted by the Association and included in the Manual embody the proper method for developing and evaluating relative benefits to the public and railways from grade crossing protection or elimination. The Committee reports on provision which should be included in uniform statutes governing highway grade crossing protection or elimination. Under the heading "Specifications for location, height and illumination of signs protecting grade crossings, the Committee suggests that illumination of the advance warning sign should be effected by the use of crystal (colorless) reflector button lenses $\frac{11}{16}$th inch in diameter set in letters "RR." The same recommendation is made with reference to the Highway Crossing Sign, the lettering to be "Railroad Crossing." The Committee offers for approval a proposed form for reporting highway crossing accidents.

Committee on Signals and Interlocking.—The Committee reports on developments of automatic control and cab signals, including tables showing voluntary installations of automatic train control, and a list of roads operating locomotives over portions of other lines equipped with train control. The report contains an exceedingly valuable report on the improvement in railway operating efficiency and progress made in the use of modern railway signal systems. The current activities of the Signal Section are reported on, to keep the members of the A.R.E.A. informed.

Committee on Records and Accounts.—In connection with the report on methods and forms for gathering data for keeping up-to-date the valuation and other records of the property of railways, the Committee presents an exhaustive list of definitions of terms; forms for bringing land valuations to a later date; a revision of the Roadway Completion Report is submitted.

A report is made on the subject of methods of avoiding duplication of effort and for simplifying and co-ordinating work under the requirements of the I.C.C. with respect to accounting, valuation and depreciation. The Committee offers for consideration a proposed form for reporting the cost of water production. A brief report is made on accounting for industry tracks in its relation to ownership and contract provisions. The Committee reports progress on the assignment "methods and forms for maintaining a record of changes in jointly owned interlocking plants, with respect to ownership and contract provisions." A comprehensive report is made on the use of mechanical devices for accounting, various devices and methods being described. To keep the members informed, a useful bibliography on subjects pertaining to records and accounts, appearing in current periodicals, is included in the report.

Committee on Rules and Organization.—The Committee has continued the preparation of "Rules for the Guidance of Employees of the Maintenance of Way Department," with special reference to maintenance of bridges; maintenance of structures other than buildings, and maintenance of telegraph and telephone lines and appurtenances. Additional rules for employees working on or about the track are presented, and minor revisions in previously adopted rules. Titles employed to designate positions of corresponding rank in maintenance of way service are proposed. As information, the Committee presents a recommended uniform registration law for professional engineers and land surveyors. This law was compiled by a committee of representatives of the American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers, New York State Society of Professional Engineers and Land Surveyors, and National Council of State Boards of Engineering Examiners.

Committee on Water Service and Sanitation.—The Committee reports progress on the cause and extent of pitting and corrosion of locomotive boiler tubes and sheets; it is keeping in touch with a number of service tests now being carried out on various railroads, and hopes to present an interesting summary of the results of such tests a year hence. The Committee has continued its study of the relative cost of eliminating impurities in locomotive boiler water and the value of treatment with respect to chemicals and compounds applied direct to locomotive boilers and roadside tanks, and presents a discussion of the relative costs and values of chemicals used in boilers or tanks. A valuable report is presented on simplification and standardization of equipment and materials used in railway water service. Another report of value is the one on automatic and remote control of pumping equipment. In a report on protection of water supply pipe lines systems from electrolysis, the Committee points out the important points which should be considered by railroads in safeguarding their water supply systems from electrolytic corrosion. The importance of accurate and constant control and supervision of water treating plants is stressed in an excellent report on the subject of chemical control and general supervision of water-softening plants. An illuminating report on protection of boilers and boiler materials from corrosion and deterioration while in storage is presented. The Committee has kept in touch with the progress being made by Federal and State authorities on regulations pertaining to drinking water supply. The Committee presents a report on methods of laying cast iron pipe and specifications.

Committee on Yards and Terminals.—Progress is reported on the assignment "provisions for parking and garage facilities for private automobiles of railway passengers at passenger terminals and way stations"; the matter is under observation by the Committee, and will be reported on fully at a later date. The report on "Hump Yards," is sub-divided into a number of headings: (1) studies; (2) track layout; (3) track gradients; car resistance on tangent track; curve resistance compensation; gradients through last retarder; (4) scales; (5) hump facilities; (6) retarder tow-

ers; (7) communication facilities; (8) yard lighting; (9) hot oil system; (10) flange oilers; and (11) summary. Under the caption, "Scales," the Committee recommends the withdrawal from the Manual of the matter under the heading "V—General Specifications for Master Scales," for the purpose of preparing a more satisfactory specification, to be presented at a later date. The report also contains an interesting bibliography of articles on railway stations, yards, marine terminals and air ports, appearing in current periodicals since the last report was made.

Committee on Iron and Steel Structures.—The Committee offers a minor change in the Specifications for Steel Highway Bridges; also, a change in the Specifications for Steel Highway Bridges, and the addition of a specification for Forged Steel. Track anchorage over bridges and similar structures is reported on, and the practice of various railroads is given. The Committee reports that information recently collected indicates an increased use of copper-bearing steel for structural purposes, that four of the largest railroad systems are now specifying copper-bearing steel for railway bridges, and that there is an increase in the use of this material for turntables, for roof and side panels on steel buildings. The Committee offers for approval revisions of the chapter on "Workmanship" in the General Specifications for Steel Railway Bridges, to cover punched and reamed work. The Committee submits as information a discussion of the longitudinal forces as they apply to railway bridge superstructures and substructures; also, a design of rivet heads for steel structures.

Committee on Economics of Railway Location.—In its report presented a year ago, the Committee submitted a method for choosing an electric locomotive for a specified service. In the current report, this method is illustrated and a problem is stated in electric locomotive selection together with a solution. The Committee has continued its study of the extent train resistance is increased when trains are operated on flexible rails as compared with the same operation with stiffer rails, and points out that the heavier rail sections are factors in decreasing train resistance in operation due to less flexibility. The Committee offers for approval a final report on the proper size and character of field organizations for railway location and construction.

Committee on Wood Preservation.—Continuing its practice of former years, the Committee has made available in the form of statistics, a large amount of valuable data on service test records of treated ties, including tie renewals per mile maintained on various railroads; reports on inspection of cross-tie test tracks on the Burlington, Great Northern, Rock Island, St. Louis Southwestern, Chicago, Milwaukee, St. Paul & Pacific, and Soo Line. Through a Sub-Committee, developments have been recorded on the subject of piling used for marine construction; it is also co-operating with the Chemical Warfare Service of the U. S. Army in observing test pieces placed at various points throughout the country of various tropical timbers which have been reported to be resistant to marine borer attack. Progress is being reported on the study of destruction by termite and possible ways of preventing same. As a result of its study of the practicability of boring bridge and switch ties for spikes before treatment, the Committee is of the opinion that the preboring of bridge ties for spike holes prior to treatment is practicable and an economical thing to do.

Committee on Electricity.—The Committee briefly summarizes the reports presented at the annual session of the Electrical Section held in October, 1930. Several of these reports are of general interest to the members of the A.R.E.A., among them being the report on Power Supply, covering steam power available for traction and general power purposes; water power, and internal combustion engine power supply. Specifications for Bronze and Copper Trolley Wire were presented and approved; also, Speci-

fications for Black Varnished Cloth Tape—straight and bias cut. Revisions of the "Rules for the Protection of Oil Sidings from Danger Due to Stray Currents" were offered and approved by the Electrical Section. A revised Incandescent Lamp Standard was submitted and approved. Of particular interest to the A.R.E.A. is the report on floodlighting of railroad yards. A progress report on design of indoor and outdoor substations was presented.

Committee on Uniform General Contract Forms.—The Committee submits a report on Cost-Plus Methods in Construction Contract, supplementing the form of Cost-Plus Percentage Construction Contract heretofore adopted by the Association; the supplementary material covering Cost-Plus a Fixed Fee and Cost-Plus a Stated Sum with Adjustments for Varying Conditions. The Committee concludes that no special form of contracts for maintenance of way work is necessary and none is recommended. Progress is reported by the Committee on the preparation of a form of agreement for the purchase of electrical energy in large volume (such as required for traction purposes), and on form of agreement for the organization and operation of a joint passenger terminal project.

Committee on Economics of Railway Labor.—This Committee presents a well-considered report on effects of recent developments in maintenance of way practices on gang organization (such as use of heavier rail, treated ties, and labor-saving devices, which make practicable small section forces, and conducting the major part of maintenance work with extra gangs). In the report on this subject, reference is made to railways which have increased length and decreased number of sections; railways which have reduced track forces; roads which have transferred section work to extra gangs; and roads which report no effects on gang organization. The Committee concludes that recent developments in maintenance of way practices, such as improved materials and labor-saving devices, have reduced the amount of track labor required for adequate maintenance; and that it is apparent that these developments in maintenance of way practices should permit the transferring of the heavier routine maintenance work from section gangs to specialized gangs equipped with modern labor-saving machinery, with large resulting economy. As a result of its study of the subject "Economies resulting in the diversion of traffic on multiple track lines for maintenance purposes," the Committee concludes that under all but the most intensive traffic the practice of diverting of traffic on multiple track lines to facilitate the work of the maintenance forces is feasible, and when employed results in definite savings in the cost of doing the work, as well as in net savings to the railway; in addition to the economies effected, there are added benefits in larger production, better work, and greater safety to the workmen; the provisions necessary for diverting the traffic are comparatively simple and can be varied to meet physical conditions or conform to operating methods; that there is little, if any, added interference with train movements while the work is actually under way and operating conditions as a whole are improved, as compared with doing the work under traffic, by reason of the reduction in time required for its completion. The Committee summarizes its study of the subject "Practical methods of stabilizing maintenance of way forces" in the form of conclusions reading: "The stabilization of forces is essential to maximum economies; the practical method of stabilizing maintenance of way forces is by the establishment of a basic force that can be economically employed during slack period, and by adding to this a temporary force as required, with provision for a definite date of termination for all such positions. This will provide a fairly uniform permanent force, and train recruits to fill jobs as vacated."

Committee on Economics of Railway Operation.—This Committee, in its current report, has added another notable contribution to the study of methods of increasing the traffic capacity of a railway. The report includes a study of railroad operations with the view of increasing its capacity with its existing facilities, and a similar study by providing addi-

tional facilities. A series of conclusions are offered for approval with the view of having them prepared and presented for publication in the Manual. A formula for determining comparative economies of flat and hump yard switching is presented for approval and publication in the Manual. The Committee presents as informaton a report on suitable units for operating and equipment statistics required by the Interstate Commerce Commission to be used on cost comparisons of transportation, equipment and roadway maintenance. The Committee presents further data on the problems of railway operation as affected by the introduction of air transport lines, motor truck and bus lines, with special reference to the effect of the latter upon branch or feeder lines. The Committee reports progress on the assignment, "study and report on economies resulting from the use of radio telephone for long freight trains and for yard work."

Committee on Shops and Locomotive Terminals.—The Committee presents an interesting report on locomotive washing platforms, with a series of conclusions for publication in the Manual. Several types of permanent locomotive washing platforms installed on various railroads are illustrated in the report; also, a tabulation giving details of the practice of a number of roads. A report of progress is presented on general layouts and design of car shops. A layout plan for use with the progressive system for heavy repairs to steel and composite cars, recommended by the Mechanical Division Committee of the A.R.A., is shown; also, steel and freight car repair shops of the Rock Island and Milwaukee roads are illustrated. A progress report is made on inspection pits, with plan of a typical inspection pit.

Committee on Rivers and Harbors.—The report is presented under two main headings, "Rivers" and "Harbors." Definitions of terms used in construction and maintenance of rivers and harbors are submitted. The Committee recommends that the "Specifications for Levee Construction," appearing in Volume 31, Proceedings for 1930, pp. 1346-1350, inclusive, be approved for publication in the Manual. The Committee also submits specifications covering the several types of river bank protection and levees in common use. Report on various types of dredges and their respective uses, together with dredging specifications, is submitted for approval and publication in the Manual.

Special Committee on Maintenance of Way Work Equipment.—This recently formed Committee presents its first annual report. A series of definitions of terms used in connection with maintenance of way work equipment are presented for approval and publication in the Manual. In connection with standardization of parts and accessories of railway maintenance motor cars, the Committee presents for approval plans covering couplers, safety rails and tool trays. As a result of its study of the subject methods of alarm for gasoline propelled track cars, the Committee considers the use of warning devices on track cars unnecessary except under special conditions. The Committee submits as information a report on methods of scheduling and assigning of work equipment; methods of keeping data on work equipment and labor-saving devices, and forms for keeping such records; organization for use and maintenance of tie tamping machines; care of work equipment when not in use, with special reference to proper housing. Recommendations are submitted for approval relating to standard colors for work equipment and motor cars. The Committee reports progress on the standardization of voltage and kind of current for use in electrically operated machines and tools for roadway purposes, and on the best practice of maintaining labor-saving devices on construction and maintenance of way work, and the organization of the necessary supervisory force.

Special Committee on Standardization.—This Committee, composed of the Chairmen of all Standing and Special Committees and members representing Canadian practice, considers its functions to be to encourage the use of A.R.E.A. recommended practices in the railway field, and to promote.

as national standards, such subjects as may be selected for sponsoring by the Board of Direction; to maintain contact with standardization bodies and keep the Association informed on important matters developed by such contact. The current report calls attention to the approval of the A.R.E.A. Manual by the American Railway Association as an aid in the extension of uniform practice. A classification of A.R.E.A. recommended practices according to use is included in the report. The representation of the American Railway Association in American Standards Association is given in the report. Reference is also made to Canadian Engineering Standards Association, other national standardization bodies, International Standards Association, and the Paris Conference. The report concludes with a table showing "American Standards" approved by A.S.A. from September 1, 1929, to September 1, 1930, and a list of technical projects on which railway associations are now co-operating.

Special Committee on Clearances.—The Committee presents for approval clearance diagrams for bridges and tunnels, buildings and sheds, warehouses and engine house doors, and for platforms. In co-operation with the Car Construction Committee of the Mechanical Division, A.R.A., on the assignment covering clearances as affected by half-through inter-track girders and other structures, the Committee has issued a questionnaire covering the outline of a proposed standard box car, a diagram covered by this assignment to be submitted at a later date.

Special Committee on Stresses in Railroad Track.—The Committee reports progress on its study of the rail-joint. It is expected to conduct tests on track on two or more railroads during 1931. Committee reports that considerable work has been carried out on laboratory tests on several types of rail-joint to determine several features in the action of the joints, including the influence of the position of the load, the deflection and stiffness of joints, and the relative lateral and vertical movements between bar and rail.

CO-OPERATION WITH TECHNICAL ORGANIZATIONS

The Association is collaborating with other technical organizations in the study of problems of mutual concern. The advantages of such collaboration are manifold and are of distinct benefit to the participating associations. A list of the associations with which we are co-operating is given below:

American Society of Civil Engineers.
American Society for Testing Materials.
American Standards Association.
Central Committee on Lumber Standards.
Chemical Warfare Service, U.S. Army.
Highway Research Board, National Research Council.
Joint Committee on Automatic Train Control.
Joint Committee on Concrete and Reinforced Concrete.
Joint Committee on Grade Crossing Protection.
Joint Committee on Railway Sanitation.
Manganese Track Society.
Mechanical Division, American Railway Association.
Motor Transport Division, American Railway Association.
National Electric Light Association.
National Scalemen's Association.
National Committee on Wood Utilization.
Portland Cement Association.
Rail Manufacturers' Technical Committee.
University of Illinois Engineering Experiment Station.

Personnel of Committees by Railways—1930

Railroads	Roadway	Ballast	Ties	Rail	Track	Buildings	Wooden Bridges and Trestles	Masonry	Grade Crossings	Signals and Interlocking	Records and Accounts	Rules and Organization	Water Service	Yards and Terminals	Iron and Steel Structures	Economics of Railway Location	Wood Preservation	Electricity	Uniform General Contract Forms	Economics of Railway Operation	Economics of Railway Labor	Shops and Locomotive Terminals	Co-operative Relations with Universities	Rivers and Harbors	Stresses in Railroad Track	Clearances	Standardization	Maintenance of Way Work Equipment	TOTALS
Atlantic Coast Line				1							2								1						1			1	6
Akron, Canton & Youngstown														1															1
Atchison, Topeka & Santa Fe	3	2	2	2	1	1	1	2	1	1		2	1	1	1	1	1	1		1	2	1		1		1	1	1	32
Gulf, Colorado & Santa Fe																								1					1
Baltimore & Ohio	2	1		2	1	2	1	2	2	1	1	1	2	1	1	1	1	2	1	2	3	1			2	2	3	1	39
Baltimore & Ohio Chicago Terminal			1						1																				2
Bessemer & Lake Erie											1					1				2		1					1		6
Boston & Maine	2			1		1		1			2	1		2		1	1	1			2	1		1			1		18
Buffalo, Rochester & Pittsburgh																												1	1
Canadian National		1	1	2	2	1	1	1		1			1		1	1	1	1	1	3		1		1			1	1	23
Grand Trunk Western						1		1				1		1					1										5
Canadian Pacific	1		1	1	1	1		1		1			1	1	1	1	1					1	1	1		1		1	17
Central of Georgia			1			1	1		1								1		1					1				1	8
Chesapeake & Ohio	2	3	2	1	1	1	2		1	1	4	1	3	2		3			1	4	2	3	1	1		1	2	2	44
Hocking Valley	1				1	1	1	1		1	1					1				1									9
Chicago & Alton		1											1																2
Chicago & Illinois Midland																					1								1
Chicago & Eastern Illinois										1					1							1						1	4
Central Railroad of New Jersey								1				1		1				2	1	1								1	8
Chicago & Northwestern	1			1	1				1	1	1	1	1		1			1		1		1							12
Chicago & Western Indiana		1			1				1					1								1							5
Chicago, Burlington & Quincy			2	2	3		1	1	2			1	1		1	1	1			1		2						1	20
Chicago Great Western											1					1													2
Chicago, Indianapolis & Louisville										1	1											1							3
Chicago, Mil., St. P. & Pacific	1	1	1	1				1	1		1		2	1			1	1		1		1	1	1				1	17
Chicago, Rock Island & Pacific	1	2		2	2	1		2	2	1	2	1	3		1		2			1		2	2		1	1	2	2	33
Chicago Rapid Transit				1																									1
Chicago, W. Pullman & Southern												1																	1
Cleveland Union Terminals																		1				1							2
Clinchfield																			1										1
Copper Range																1													1
Ch., St. P., M. & O.									1																				1
Dayton Union			1																										1
Delaware, Lackawanna & Western		1	1	1	1	2	1	1					1					1	1	1		1	1		1			1	16
Delaware & Hudson			1		1									1						1			1						5
Duluth, Missabe & Northern						1	1				1													1					4

Personnel of Committees by Railways—1930

Railroads	Roadway	Ballast	Ties	Rail	Track	Buildings	Wooden Bridges and Trestles	Masonry	Grade Crossings	Signals and Interlocking	Records and Accounts	Rules and Organization	Water Service	Yards and Terminals	Iron and Steel Structures	Economics of Railway Location	Wood Preservation	Electricity	Uniform General Contract Forms	Economics of Railway Operation	Economics of Railway Labor	Shops and Locomotive Terminals	Co-operative Relations with Universities	Rivers and Harbors	Stresses in Railroad Track	Clearances	Standardization	Maintenance of Way Work Equipment	TOTALS
Denver & Rio Grande Western							1																						1
Elgin, Joliet & Eastern					1						1			1								1							4
Erie	1	1			1	1		1	1		1		1	1		2			1		1			1	1		1	1	17
Florida East Coast	1	1			1						1	1			1							1		1				1	9
Fort Worth & Denver City							1																						1
Great Northern			2										1		1		1												5
Illinois Central	3	1	1	2	3	1	1	1	2	2	2	2	3	2		1	1	2	1	2	2	1	1	1				4	42
Illinois Terminal														1															1
Indianapolis Union														1															1
Jacksonville Terminal														1															1
Kansas City Southern			1	1					1				1		1					2	2		1				1		11
Kansas City Terminal										1				1															2
Lake Superior & Ishpeming			1																					1					2
Lehigh Valley								1				2					1				1							1	6
Louisville & Nashville	1	1	1	1			1					1		1	1									1					9
Louisiana & Arkansas											1																		1
Maine Central	1					1	1																						3
Minnesota International						1																							1
Missouri & Illinois											1																		1
Missouri-Kansas-Texas Lines	1	1	1	1		1		2	1		2		1	1	1	1					1	1				2	3	1	22
Missouri Pacific	3	1	1	1	1		3	2	2	2	2	1	3	2		1			2	1	2		1	2	2		1	2	38
Gulf Coast Lines			1																										1
International Great Northern																					2								2
Mobile & Ohio		1					1																			1	1		4
Nash., Chattanooga & St. Louis	1			1								1																	3
New York, Ontario & Western											1										1								2
New York Central Lines				1		1								1		1		1				1			1	1			8
Boston & Albany		1				1													1								1		4
Big Four		1					1				1				2	1						1							8
Indiana Harbor Belt														1															1
Evansville, Ind. & T. H.																			1										1
Michigan Central	2	1			2		1		1	1				1				1			1	1							12
New York Central Railroad	1	2	2	1	3			1	2	2	1	2	2	1	3		3	4		1	1	4		1	1	1	1	1	41
Peoria & Eastern	1																			1									2
New York, Chicago & St. Louis					1				1				1		1				1										5
New York, New Haven & Hart.	1			1		2			1	1	2			2	1			2	1	2	1		1	1		1	2	1	23
Connecticut Company											1																		1

Personnel of Committees by Railways—1930

Railroads	Roadway	Ballast	Ties	Rail	Track	Buildings	Wooden Bridges and Trestles	Masonry	Grade Crossings	Signals and Interlocking	Records and Accounts	Rules and Organization	Water Service	Yards and Terminals	Iron and Steel Structures	Economics of Railway Location	Wood Preservation	Electricity	Uniform General Contract Forms	Economics of Railway Operation	Economics of Railway Labor	Shops and Locomotive Terminals	Co-operative Relations with Universities	Rivers and Harbors	Stresses in Railroad Track	Clearances	Standardization	Maintenance of Way Work Equipment	TOTALS
Norfolk & Western				1					1				2	1	1		1	1		1			1	2	1				13
Norfolk Southern																			1										1
Northern Pacific			2	1	1	1		1	2		1		2			2	1	1		2	1						1	1	20
Northwestern Pacific				1												1							1						3
Pennsylvania	1	2	3	3	2		2	2	2	2	1	1	3	2	1	3	1	1		3			1		2	2	3	2	44
Long Island									1			1						2											4
Peoria & Pekin Union		1	1																										2
Pere Marquette	1				1																1							1	4
Pittsburgh & Lake Erie						1																							1
Reading	1	1		1	1	1					1		1		1	1	2	2				1					1		15
Richmond, Fred. & Potomac		1												1						1									3
St. Louis-San Francisco	1											1	1											1					4
St. Louis Southwestern		1											1										1						3
Seaboard Air Line						1										1			1				1						4
Soo Line																	1											1	2
Southern		1		1	2		1		1	1		1	1							1			1					1	12
Southern Pacific	2	1	1	1	2		1		2				1	1		1	3	1		1		2	1	2				1	24
Temiskaming & Northern Ontario			1																										1
Term. R. R. Assn. of St. Louis					1									1															2
Texas & Pacific													1							1		1						1	4
Third Avenue Railway System					1																								1
Toronto Terminals														1													1		2
Toledo, Peoria & Western		1																											1
Union Pacific		1		1						1		1	1		1						1							1	8
Los Angeles & Salt Lake								1																					1
Union Railroad (Memphis)			1																										1
Union Railroad (Pennsylvania)																						1							1
United Railway & Electric Co.			1								1																		2
Wabash	1		1			1	1	3	1		1		1		1				1		1								13
Wheeling & Lake Erie		1																											1
Western Maryland														1															1
Western Pacific			1						1																				2
Non-Railroad Members	2	6	1		10	4	3	12	3	1	3	1	1	13	12	8	10	4	4	8	1	4	11	4	9		1		136
Foreign Members			6		2						1		13		1	1				1									25
Total	40	42	44	38	52	32	29	42	40	25	45	27	59	52	38	38	35	33	24	48	30	40	29	27	22	14	29	37	1011

(II) MEMBERSHIP

For the first time in many years, it is necessary to record a slight loss instead of a gain in the number of members enrolled. This decrease is attributable to the industrial depression prevailing during 1930.

The Membership Committee is now making plans with a view of increasing the membership, and it is hoped a year hence to show a marked addition to the rolls.

We have not quite reached the saturation point of membership. There are still a considerable number of persons eligible for membership whose affiliation would prove mutually beneficial. Members can render a most useful service by inviting such eligible persons to become identified with the Association.

The table below gives the present status of the membership:

Membership as of March 1, 1930			2,856
Additions during the year		145	
Losses by death	36		
Resignations	55		
Dropped from rolls	119	210	
Net loss		65	65
Total Membership as of March 1, 1931			2,791

Classification of Membership.—The tabulation below indicates that the Association in its development and broadened scope, has attracted to its membership many representatives of departments other than the Engineering Department of railways. In this we are singularly fortunate, as it affords opportunity of having the various subjects studied by the Association viewed from every angle and proper representation made of the viewpoint of each department.

General Officers Includes Chairmen of Boards, Presidents, Directors, Vice-Presidents, Assistants to President, General Managers, Assistant General Managers	214
Conducting Transportation Officers Includes General and Assistant General Superintendents, Division Superintendents, Trainmasters	108
Maintenance of Way and Structures Officers Includes Chief Engineers, Chief Engineers of Maintenance of Way, Engineers Maintenance of Way, Bridge Engineers, Division Engineers, Signal Engineers, Assistant Engineers, etc.	1,879
Maintenance of Equipment Officers Includes General Superintendents of Motive Power and other Mechanical Department Officers	30
Traffic Officers	6
Accounting Officers	18
Purchasing and Stores Department Officers	5
Professors in Colleges	64
Miscellaneous Includes Consulting and Civil Engineers, Engineers of Industrial Corporations, Government and Municipal Engineers, etc.	467
Total	2,791

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Deceased Members

F. E. Abbott,
Civil Engineer

Robert Armour,
Consulting Masonry Engineer, Canadian National Railways

S. J. Bratager,
Retired Assistant Chief Engineer, Northern Pacific Railway

M. C. Byers,
President, Western Maryland Railway

J. A. Colby,
Inspection Engineer

M. W. Cooley,
Retired General Manager, Uintah Railway (Charter Member)

F. M. Davison,
Building Engineer, Valuation Department, New York Central Lines

Walt Dennis,
Superintendent, New Jersey, Indiana & Illinois Railroad

C. L. Doub,
Assistant Engineer, Reading Company

J. H. Edwards,
Chief Engineer, American Bridge Company

S. M. Felton,
Chairman, Board of Directors, Chicago Great Western Railroad (Charter Member)

J. H. Gallivan,
Division Engineer, New York, New Haven & Hartford Railroad

A. L. Grandy,
Assistant to Vice-President, Pere Marquette Railway

A. L. Greenebaum,
Civil Engineer

Albert Hansen,
Assistant Engineer, Baltimore & Ohio Railroad

A. E. Harvey,
Chief Engineer, Kansas City Public Service Company

A. H. Hogeland,
Consulting Engineer, Great Northern Railway

H. J. Hughes,
Dean, Engineering School, Harvard University

Deceased Members

L. E. Hyatt,
Supervisor of Water Service, Missouri Pacific Railroad

P. B. Jeffries,
Assistant Engineer, Illinois Central Railroad

L. L. Kelly,
Bridge Engineer, Norfolk & Western Railway

Walter T. Krausch,
Engineer of Buildings, Chicago, Burlington & Quincy Railroad

T. H. Lantry,
General Manager, Northern Pacific Railway

John Lundie,
Consulting Engineer

Charles H. Markham,
Chairman of Board, Illinois Central System

G. A. McCarthy,
Assistant Engineer, City Hall, Toronto, Ont., Canada

W. A. McGonagle,
President, Duluth, Missabe & Northern Railway (Charter Member)

Frank Merritt,
Chief Engineer, Gulf, Colorado & Santa Fe Railway

Richard Montfort,
Consulting Engineer, Louisville & Nashville Railroad (Charter Member)

C. E. Phelps,
Assistant Engineer, Missouri Pacific Railroad

J. W. Raitt,
Assistant Engineer, Norfolk & Western Railway

W. M. Robinson,
President and General Manager, Augusta & Summerville Railroad

A. L. Sarvey,
Valuation Engineer, Michigan Central Railroad.

R. M. Sias,
Chief Engineer, Galveston Wharf Company

Elmer A. Sperry,
President, Sperry Development Company

W. J. Towne,
Chief Engineer, Chicago & Northwestern Railway

GEOGRAPHICAL DISTRIBUTION OF MEMBERSHIP

United States and Possessions

Alabama	7	Nebraska	38
Arizona	3	New Jersey	51
Arkansas	29	New Hampshire	6
California	76	New Mexico	1
Colorado	16	New York	254
Connecticut	29	North Carolina	23
Delaware	1	North Dakota	3
District of Columbia	35	Ohio	162
Florida	25	Oklahoma	22
Georgia	44	Oregon	9
Hawaii	1	Pennsylvania	198
Idaho	8	Philippine Islands	3
Illinois	354	Porto Rico	1
Indiana	53	Rhode Island	3
Iowa	24	South Dakota	1
Kansas	60	Texas	120
Kentucky	43	Tennessee	22
Louisiana	22	Utah	7
Maine	15	Vermont	9
Maryland	61	Virginia	113
Massachusetts	69	Washington	29
Michigan	59	West Virginia	35
Minnesota	77	Wisconsin	17
Mississippi	13	Wyoming	3
Missouri	236		
Montana	11		**2501**

Other Countries

Canada	146	Korea	2
Japan	31	France	1
South America	20	Manchuria	5
Mexico	13	Siam	2
Cuba	9	Czecho-Slovakia	2
England	9	Scotland	3
Union Soc. Sov. Rep.	12	New Zealand	1
China	8	Poland	1
Australia	7	Spanish Honduras	1
India	5	Sudan	1
Central America	3	Sweden	1
Germany	2	Switzerland	1
Africa	1	Jamaica	1
Costa Rica	2		
			290

Railway Executives on Membership Rolls.—It is gratifying to have the active interest and affiliation of the principal Railway Executives in the work of the Association. It is a privilege to record the names of Presidents holding membership in the Association and the roads they direct:

Algoma & Eastern Railway	Grant Hall, President
Atchison, Topeka & Santa Fe	W. B. Storey, President
Atlanta, Birmingham & Coast	B. L. Bugg, President
Atlantic Coast Line	G. B. Elliott, President
Baltimore & Ohio	Daniel Willard, President
Bangor & Aroostook	Percy R. Todd, President
Boston & Maine Railroad	E. S. French, President
Buffalo, Rochester & Pittsburgh	W. T. Noonan, President
Canadian National	Sir Henry W. Thornton, Chairman and President
Canadian Pacific	E. W. Beatty, Chairman and President
Central of Georgia	A. E. Clift, President
Central of New Jersey	W. G. Besler, Chairman of Board R. B. White, President
Chicago, Burlington & Quincy	F. E. Williamson, President
Chicago Great Western	V. V. Boatner, President
Chicago, Rock Island & Pacific	J. E. Gorman, President
Chicago & Northwestern	F. W. Sargent, President
Colorado & Wyoming	J. F. Welborn, President
Chicago & Western Indiana	E. H. Lee, President
Delaware, Lackawanna & Western	J. M. Davis, President
Denver & Rio Grande Western	J. S. Pyeatt, President
Elgin, Joliet & Eastern	A. F. Banks, President
Erie	C. E. Denney, President
Eureka & Nevada	J. H. Sherburne, President
Great Northern	Ralph Budd, President
Huntingdon & Broad Top Mountain	J. Bancroft, President
Illinois Central	L. A. Downs, President
International Railways of Central America	Fred Lavis, President
Jacksonville Terminal	J. L. Wilkes, President
Kansas City Southern	C. E. Johnston, President
Lehigh Valley	E. E. Loomis, President
Louisville & Nashville	W. R. Cole, President
Minneapolis, St. Paul & Sault Ste. Marie	C. T. Jaffray, President
Montana, Wyoming & Southern	M. A. Zook, President
Missouri Pacific	L. W. Baldwin, President
Missouri-Kansas-Texas	C. Haile, President
New York Central Lines	P. E. Crowley, President
New York, New Haven & Hartford	J. J. Pelley, President
Nickel Plate Road	W. L. Ross, President
Northern Pacific	Charles Donnelly, President
Norfolk & Western	A. C. Needles, President
Pennsylvania System	W. W. Atterbury, President
Peoria & Pekin Union	E. I. Rogers, President
Rapid City, Black Hills & Western Railway	F. E. Clarity, President
Reading	A. T. Dice, President
Richmond, Fredericksburg & Potomac	E. Hunton, Jr., President
Sand Springs Railway	T. H. Steffens, President
St. Louis-San Francisco	J. M. Kurn, President
St. Louis Southwestern	Daniel Upthegrove, President
Seaboard Air Line	L. R. Powell, Jr., President
Southern Pacific	Hale Holden, Chairman Executive Committee A. D. McDonald, Vice-Chairman, Executive Committee Paul Shoup, President
Southern Railway System	Fairfax Harrison, President
Tennessee, Alabama & Georgia	Geo. H. Burgess, President
Tennessee Central	H. W. Stanley, President
Terminal Railroad Assn. of St. Louis	Henry Miller, President
Toledo Terminal	A. B. Newell, President
Union Pacific	Carl R. Gray, President
Wabash	J. E. Taussig, President
Western Pacific	T. M. Schumacher, Chairman Executive Committee

Representing 208,492 miles of railroad.

RAILWAYS REPRESENTED IN THE A.R.E.A., MILEAGE AND NUMBER OF MEMBERS

	Mileage	*Number of Members*
Akron, Canton & Youngstown Railway	171	5
Algoma Central & Hudson Bay Railway	323	1
Alton & Southern Railroad	32	1
Ann Arbor Railroad	332	1
Arkansas Railroad Company	20	1
Arkansas & Louisiana Missouri Railway	85	1
Atchison, Topeka & Santa Fe Railway System	9,627	71
Atlanta, Birmingham & Coast Railroad	637	3
Atlanta & West Point Railroad	227	2
Atlantic City Railroad	164	1
Atlantic Coast Line Railroad	5,310	19
Baltimore & Ohio Railroad System	5,640	92
Bangor & Aroostook Railroad	619	5
Bessemer & Lake Erie Railroad	228	5
Bingham & Garfield Railroad	40	1
Boston & Maine Railroad	2,090	35
Brantford Steam Railroad	....	1
Brooklyn-Manhattan Transit Corporation	....	1
Buffalo, Rochester & Pittsburgh Railway	602	5
Burlington-Rock Island Railroad	367	1
Butte, Anaconda & Pacific Railway	65	1
Canadian National Railways	21,686	71
Central Vermont Railway	462	3
Grand Trunk Western Railway	1,448	10
Canadian Pacific Railway	15,297	41
Cedar Rapids & Iowa City Railway	28	1
Central of Georgia Railway	2,021	25
Central Railroad of New Jersey	693	14
Chesapeake Beach Railway	28	1
Chesapeake & Ohio Railway	3,089	104
Chicago, Burlington & Quincy Railroad	9,325	33
Chicago Great Western Railroad	1,495	10
Chicago, Indianapolis & Louisville Railway	652	3
Chicago, Milwaukee, St. Paul & Pacific Railway	11,353	34
Chicago, Rock Island & Pacific Railway	7,592	59
Chicago Rapid Transit Company	....	2
Chicago, St. Paul, Minneapolis & Omaha Railway	1,747	3
Chicago, West Pullman & Southern Railway	31	1
Chicago & Alton Railroad	1,028	3
Chicago & Eastern Illinois Railway	946	5
Chicago & Illinois Midland Railway	102	1
Chicago & Northwestern Railway	8,459	14
Chicago & Western Indiana Railroad	71	11
Cincinnati Union Terminal Company	....	5
Cleveland Union Terminals Company	60	3
Colorado & Southern Railroad	1,035	2
Colorado & Wyoming Railroad	40	1
Columbia & Cowlitz Railway	8	1
Copper Range Railroad	108	1
Danville & Western Railway	83	1
Delaware, Lackawanna & Western Railroad	998	23
Delaware & Hudson Company	924	14
Denver & Rio Grande Western Railway	2,562	6
Denver & Salt Lake Railroad	232	1
Des Moines Union Railway	28	1
Detroit & Toledo Shore Line Railroad	50	3
Duluth, Missabe & Northern Railway	568	5
Elgin, Joliet & Eastern Illinois Railway	453	7
Erie Railroad	2,560	37
Eureka-Nevada Railroad	88	1
Florida East Coast Railway	867	12
Fort Smith & Western Railroad	250	1
Fort Worth & Denver City Railroad	697	3
Galveston, Houston & Henderson Railroad	50	1
Georgia & Florida Railroad	502	1
Great Northern Railroad	8,605	18
Gulf, Mobile & Northern Railroad	733	2
Houston Belt & Terminal Railway	24	1
Hudson & Manhattan Railroad	9	1
Huntingdon & Broad Top Railroad & Coal Company	74	1
Illinois Central System	6,762	91
Illinois Traction System	520	4
Indianapolis Union Railway	16	1
Inter-California Railway	52	1
Interstate Railway	74	1
Jacksonville Terminal Company	51	1
Johnstown & Stony Creek Railroad	3	1

RAILWAYS REPRESENTED IN THE A.R.E.A., MILEAGE AND NUMBER OF MEMBERS—Continued

	Mileage	Number of Members
Kansas City Southern Railway	916	15
Kansas City Terminal Railway	26	4
Kentucky & Indiana Terminal Railroad	8	1
Key System Transit Company	135	1
Lake Superior & Ishpeming Railroad	161	1
Lehigh Valley Railroad	1,362	10
Lehigh & Hudson River Railroad	97	1
Lehigh & New England Railroad	217	4
Long Island Railroad	404	5
Los Angeles Union Stock Yards	....	1
Louisiana Railway & Navigation Company of Texas	204	1
Louisiana & Arkansas Railroad	608	2
Louisville & Nashville Railroad	5,250	18
Maine Central Railroad	1,121	5
Midland Continental Railroad	69	1
Midland Valley Railroad	363	1
Minneapolis, St. Paul & Sault Ste. Marie Railway	4,378	8
Minneapolis & St. Louis Railroad	1,627	4
Minnesota Transfer Railway Company	140	1
Minnesota & International Railway	211	1
Mississippi Central Railroad	150	1
Missouri-Illinois Railroad	202	1
Missouri-Kansas-Texas Lines	3,189	36
Missouri Pacific Railroad	7,451	177
Gulf Coast Lines	1,173	13
International Great Northern Railway	1,160	5
Missouri & North Arkansas Railway	365	2
Mobile & Ohio Railroad	1,159	4
Montana, Wyoming & Southern Railroad	34	2
Montour Railroad	57	2
Montreal Tramways Company	....	1
Muncie & Western Railroad	4	1
Nashville, Chattanooga & St. Louis Railroad	1,203	6
National Railways of Mexico	6,920	8
Newburgh & South Shore Railroad	82	1
New Orleans & Great Northern Railroad	277	1
New Orleans & Lower Coast Railroad	60	1
New Orleans & Northeastern Railway	202	1
New York Central Railroad	5,729	98
Boston & Albany Railroad	410	11
Chicago Junction Railway	240	2
Cleveland, Cincinnati, Chicago & St. Louis Railway	2,741	39
Evansville, Indianapolis & Terre Haute Railway	137	1
Indiana Harbor Belt Railroad	120	1
Michigan Central Railroad	1,858	18
Peoria & Eastern Railway	211	1
Pittsburgh & Lake Erie Railroad	231	3
New York, Chicago & St. Louis Railroad	1,691	19
New York, New Haven & Hartford Railroad	2,133	35
Connecticut Company	....	1
New York, Ontario & Western Railway	569	4
Niagara Junction Railway	6	1
Norfolk Southern Railroad	933	3
Norfolk & Western Railway	2,240	22
Northern Pacific Railway	6,962	48
Northwestern Pacific Railroad	440	3
North & South Railroad	41	1
Oklahoma Railway	155	1
Oregon & Northwestern Railway	51	1
Pennsylvania Railroad System	10,512	84
Peoria & Pekin Union Railroad	168	2
Pere Marquette Railway	2,241	12
Piedmont & Northern Railroad	175	1
Pittsburg & Shawmut Railroad	103	1
Pittsburgh & West Virginia Railway	92	1
Pittsburgh, Chartiers & Youghiogheny Railroad	23	1
Pittsburgh, Lisbon & Western Railroad	23	1
Portland Terminal Company	49	1
Public Service Railway of New Jersey	40	1
Pullman Railroad	6	1
Reading Company	1,628	28
Richmond, Fredericksburg & Potomac Railroad	118	3
Rio Grande & Eagle Pass Railroad	25	1
Rutland Railroad	413	3
Sacramento Northern Railroad	269	1
Sand Springs Railway	10	1
San Francisco, Napa & Calistoga Railway	46	1

RAILWAYS REPRESENTED IN THE A.R.E.A., MILEAGE AND NUMBER OF MEMBERS—Continued

	Mileage	*Number of Members*
Savannah & Atlanta Railroad	147	1
Seaboard Air Line Railway	4,492	26
Southern New England Railroad	....	1
Southern Pacific System	9,130	54
Southern Pacific Company of Mexico	1,370	3
Texas & New Orleans Railway	4,722	1
Southern Railway System	8,051	34
Spokane International Railroad	166	1
Staten Island Rapid Transit Company	23	1
St. Louis-San Francisco Railway	5,811	13
St. Louis Southwestern Railway	1,817	15
Tela Railroad	234	1
Temiskaming & Northern Ontario Railway	443	1
Tennessee Central Railroad	296	1
Tennessee Coal, Iron & Railroad Company	....	1
Terminal Railroad Association of St. Louis	62	1
Texarkana & Fort Smith Railroad	81	2
Texas Electric Railway	230	1
Texas Pacific-Missouri Pacific Terminal Railroad of New Orleans	10	1
Texas & New Orleans Railroad	4,701	16
Texas & Pacific Railway	1,956	12
Third Avenue Railway Corporation	....	1
Toledo, Peoria & Western Railroad	239	1
Toledo Terminal Railroad	29	3
Toledo & Western Railway	79	2
Toronto, Hamilton & Buffalo Railway	111	1
Toronto Terminals Railway	....	4
Trinity & Brazos Valley Railway	....	2
Twin City Rapid Transit Company	....	1
Union Pacific Railroad	3,765	34
Los Angeles & Salt Lake Railroad	1,230	11
Oregon Short Line Railroad	2,539	11
Oregon, Washington Railroad & Navigation Company	2,365	5
Union Railway (Memphis)	18	2
Union Railroad (Pittsburgh)	46	2
United Railways & Electric Company	....	1
Utah Railway	111	1
Virginian Railway	545	7
Wabash Railway	2,524	42
Washington, Idaho & Montana Railroad	50	1
Washington Terminal Company	2	1
Waterloo, Cedar Falls & Northern Railway	113	1
Western Maryland Railroad	878	11
Western Pacific Railroad	1,052	4
Wheeling & Lake Erie Railroad	537	5

(III) PUBLICATIONS

The Monthly Bulletin.—The Bulletin is the medium through which the members are kept informed currently of the activities of the Association, its committees, and the contributions, in the form of monographs, contributed by members and others, on subjects pertinent to the objects of the Association. Ten numbers of the Bulletin are issued annually (April and May omitted).

The Proceedings.—The annual volume of Proceedings forms the permanent record of the activities of the Association. The volume contains the committee reports, the discussions thereon at the annual meeting, and the action taken. The thirty-one volumes published are a veritable encyclopedia of information on the Science of Railway Engineering.

The Manual.—The "Manual of Recommended Practice for Railway Engineering" is the *net result* of the Association's achievements for the past 30 years. It exemplifies in condensed form what the Association as a whole considers the best current practice for Railway Engineering and Maintenance of Way Work. A copy of this indispensable publication should be in the library of every member of the Association.

In June of last year, at the request of Dr. Julius Klein, Assistant Secretary of the U. S. Department of Commerce, a copy of the current "Manual" of the American Railway Engineering Association was transmitted to the Commercial Attaché at Bogota, Colombia, South America. The following letter of appreciation is of interest:

> "Several months ago you were kind enough to send to me, at my cable request, standards for railway equipment and accessories used by many of the American railways. These were presented to Dr. German Uribe Hoyos, at present Minister of Public Works. He is in favor of American railway materials and whenever possible specifies American standards. According to several manufacturers' agents the adoption of the American standards has resulted in our obtaining an increased share of the requirements.
>
> "Obviously, the quantities ordered since the standards arrived have been small. Surplus material carried over from the 'peak days' and forced economy brought about by the economic crisis have been responsible for the sharp decline in orders. An improvement may take place late in 1931."

Track-Work Plans.—During the past twelve years, the Committee on Track, in cooperation with representatives of manufacturers, has prepared approximately 180 plans and specifications for frogs, switches, crossings and guard rails. This valuable material has been assembled in a looseleaf portfolio, printed on good quality bond paper, suitable for making blueprint copies.

The use of these specifications and plans by railroads is in the direction of uniformity and of good practice, which in turn will ultimately be reflected in lower costs and prompt delivery.

It would be decidedly advantageous to place a copy of this useful volume in the office of every railway officer concerned with trackwork, and particularly in every engineering department drafting room. It represents a vast amount of painstaking labor over a period of years, and also involved a very considerable expense.

Index of the Proceedings.—Last year, Frank R. Judd, Engineer of Buildings of the Illinois Central System, prepared for the use of his Company a subject-index of the material in the annual volumes of the A.R.E.A. relating to "Buildings." This valuable compilation was so well done that other committees were requested to perform a similar service. Practically all committees have now responded, and it is planned to issue the various index chapters in future Bulletins.

This subject-index will serve a temporary purpose as a useful adjunct to the Proceedings until the "General Index" is issued. The "General Index" will of course go into greater detail.

Monographs.—Papers contributed by individual members and others during the year and published in the Bulletins were as follows:

"Railroad Consolidation," by Charles Donnelly, President, Northern Pacific Railway (address delivered at Annual Dinner of the A.R.E.A., March 12, 1930).

"The New Industrial Revolution," by Prof. Gus. W. Dyer, Professor of Economics, Vanderbilt University (address delivered at Annual Dinner of the A.R.E.A., March 12, 1930).

"Endurance Properties of Some Special Rail Steels," by John R. Freeman, Jr., and R. D. France, Metallurgists, Bureau of Standards.

"The Estimating of Changes in Operating Costs," by Maurice Coburn, Assistant Engineer, Pennsylvania Railroad.

"Transportation," by Major Mott Sawyer, Superintendent, Chicago, Milwaukee, St. Paul & Pacific Railway (paper presented to World Engineering Congress, Tokyo, Japan, November 7, 1929).

"The Electrification of the Cleveland Union Terminal," by H. A. Currie, Electrical Engineer, New York Central Railroad (presented at the Second Annual Session, Electrical Section, October 29, 1930).

Written Discussions.—The value of the Association's work can be materially increased by the development of systematic and careful discussion of its reports. For any given subject there are many members who have opinions and experience and who can supplement or constructively criticize the matter presented by a committee. The addition of such information increases the value of a committee report and of the published Proceedings, and in this way confers benefits on the engineering profession and the railway service in general. Written discussions are highly desirable and are valuable in proportion to their definiteness.

(IV) FINANCES

Exhibit A, on a following page, is a statement of receipts and disbursements for the calendar year 1930. By reference thereto it will be noted that notwithstanding the business depression during that period, we are fortunate in being able to show a comfortable margin of receipts over disbursements.

There is also a report on the "Stresses in Railroad Track fund." This fund was contributed by the various steel companies in this country and Canada to defray the expenditures of the Special Committee on Stresses in Railroad Track. In addition to above contributions, the American Railway Association is appropriating $8,000 per year towards this purpose.

The General Balance Sheet shows the Association to be in sound financial condition.

(V) MISCELLANEOUS

Laboratory Investigation of Imperfections in Steel Rails.—In the early part of 1930, the Rail Committee presented a plan for laboratory experiments of imperfections in steel rails as rolled, to be carried out under the joint supervision of the Rail Committee and the Rail Manufacturers' Technical Committee. The program and an estimate of the cost were outlined by the Chairman of the Rail Committee at the annual meeting of the Association in 1930. The plan was endorsed by the convention and ordered transmitted to the Board of Directors of the American Railway Association with the recommendation that favorable action be taken thereon. At the annual meeting of the American Railway Association on November 19, 1930, the Board of Directors authorized an appropriation of $25,000 per annum over a five-year period, with the understanding that Rail Manufacturers would contribute a similar amount to finance the undertaking.

The work is to be conducted at the Engineering Experiment Station of the University of Illinois, Urbana, Illinois, under the supervision of the following Joint Sub-Committee:

Representing the Rail Committee of the American Railway Engineering Association—Earl Stimson, Vice-Chairman of the Joint Sub-Committee; C. B. Bronson, E. E. Chapman, W. C. Cushing, G. J. Ray, A. F. Blaess, W. C. Barnes.

Representing Rail Manufacturers—F. M. Wood, Chairman Joint Sub-Committee; L. S. Marsh, John Brunner, Dr. J. S. Unger, C. F. W. Rys, E. F. Kenney.

The Association's New Headquarters.—In April, 1930, the offices of the Association were removed to the 22d floor of the Buckingham Building, 59 East Van Buren Street, Chicago. The A.R.E.A. leases the space required by it from the American Railway Association. The latter association has taken a long-term lease on the 22d and 23d floors of this newly constructed building.

Amendment to Constitution.—A petition, signed by twenty-six Members was presented to the Board of Direction, proposing an amendment to the Constitution, relative to the requirements for membership. It was proposed to amend Article II, Section 2, Membership, by adding, at the end of the paragraph, the following wording:

> "In determining the eligibility of candidates to the grade of Member, graduation in an engineering school of recognized standing shall be considered as equivalent to three years of active practice, and the satisfactory completion of each year of work in such a school without graduation shall be considered as equivalent to one-half year of active practice."

The amendment was submitted to letter-ballot of the membership under date of June 1, 1930. The result of the letter-ballot was as follows:

For the amendment.............................. 663 votes
Against the amendment........................... 51 votes

A two-thirds majority having voted in favor of the amendment, it will become effective at the close of the annual meeting, March 11, 1931.

Exceptional Committee-Service Records.—It is of interest to note that several members have served on committees for long periods. The files of the Association reveal the following interesting facts:

E. E. R. Tratman, on Yards and Terminals Committee 32 years.

W. C. Cushing, Chairman, Vice-Chairman and member of various committees for 31 years.

Thos. S. Stevens, on Signals and Interlocking Committee 31 years.

A. H. Rudd, on Signals and Interlocking Committee 30 years.

J. C. Mock, on Signals and Interlocking Committee 30 years.

Henry Lehn, on Records and Accounts Committee 25 years.

A. Montzheimer, Chairman, Vice-Chairman and member Yards and Terminals Committee 20 years.

J. C. Irwin, Chairman, Vice-Chairman and member Committee on Uniform General Contract Forms 22 years.

C. A. Wilson, Vice-Chairman and member Committee on Uniform General Contract Forms 22 years.

Prof. C. Frank Allen, on Committee on Uniform General Contract Forms 19 years.

Dean F. E. Turneaure, on Committee on Iron and Steel Structures 23 years.

F. O. Dufour, on Iron and Steel Structures Committee 23 years.

Albert Reichmann, on Iron and Steel Structures Committee 23 years.

O. E. Selby, Chairman, Vice-Chairman and member of Committee on Iron and Steel Structures 18 years.

B. R. Leffler, Chairman, Vice-Chairman and member of Committee on Iron and Steel Structures 16 years.

W. D. Faucette, Chairman, Vice-Chairman and member of Committee on Uniform General Contract Forms 14 years.

O. F. Dalstrom, Chairman and member of Committee on Iron and Steel Structures 10 years.

A. F. Dorley, Chairman, Vice-Chairman and member of Committee on Water Service 13 years.

Reporters for International Railway Congress Association.—Two members of the Association have been honored with appointment as "Reporter" for the meeting of the International Railway Congress Association, to be held at Cairo, Egypt, in 1933: Sidney Withington, Electrical Engineer, New York, New Haven & Hartford Railroad, to report on "Electrification of railways from an economical point of view; selection of sites for generating stations; choice of the kind of current; safety precautions, etc."; and F. M. Thomson, District Engineer, Missouri-Kansas-Texas Lines, to report on "The use of mechanical appliances in the permanent way maintenance and in track relaying."

Acknowledgment.—In conclusion, it is the Secretary's pleasant duty to acknowledge the loyal and efficient performance of duty by the office staff during the past year.

Exhibit A

FINANCIAL STATEMENT FOR CALENDAR YEAR ENDING DECEMBER 31, 1930

Balance on hand January 1, 1930		$49,279.10
RECEIPTS		
Membership Account		
Entrance Fees	$ 1,360.00	
Dues	27,589.04	
Binding Proceedings	2,256.00	
Badges	16.00	
Sales of Publications		
Proceedings	1,696.28	
Bulletins	1,569.69	
Manual	7,401.75	
Specifications	951.79	
Leaflets	613.46	
Advertising		
Publications	2,485.20	
Interest Account		
Investments	2,005.00	
Bank Balance	165.22	
Annual Meeting		
Sale of Dinner Tickets	4,525.00	
Miscellaneous	192.39	
American Railway Association		
Rail Investigations	9,700.40	
Total	$62,527.22	
DISBURSEMENTS		
Salaries	$ 8,239.92	
Proceedings	7,154.33	
Bulletins	12,273.49	
Manual	10,452.96	
Stationery and Printing	1,525.51	
Rents, Light, etc.	830.00	
Supplies	515.31	
Expressage	1,068.61	
Postage	981.39	
Exchange	153.55	
Committee Expenses	157.05	
Officers' Expenses	241.06	
Annual Meeting	5,621.48	
Refund Dues, etc.	119.20	
Audit	200.00	
Pension (A. K. Shurtleff)	1,200.00	
Furniture	188.80	
Miscellaneous	200.60	
American Railway Association—Rail Investigations	9,543.67	
Total	$60.666.93	
Excess of Receipts Over Disbursements		$ 1,860.29
Balance on hand December 31, 1930		51,139.39
Consisting of		
Bonds at Cost	$40,785.89	
Cash in National Bank of Republic	10,328.50	
Petty Cash Fund	25.00	
	$51,139.39	

REPORT OF THE TREASURER

Balance on hand January 1, 1930		$49,279.10
Receipts during 1930	$62,527.22	
Paid out on Audited Vouchers, 1930	60,666.93	
Excess of Receipts over Disbursements		1,860.29
Balance on hand December 31, 1930		$51,139.39
Consisting of:		
Bonds at Cost	$40,785.89	
Cash in National Bank of Republic	10,328.50	
Petty Cash Fund	25.00	
	$51,139.39	

STRESSES IN TRACK FUND

Balance on hand January 1, 1930	$11,552.18
Received from Interest during 1930	229.70
Total	$11,781.88
Paid out on Audited Vouchers during 1930	2,745.43
Balance of fund on hand December 31, 1930	$ 9,036.45

The Securities listed above are in a safety deposit box of the National Bank of the Republic.

Respectfully submitted,

A. F. Blaess,

Treasurer.

I have made an audit of the accounts of the American Railway Engineering Association for the year ending December 31, 1930, and find them to be in accordance with the foregoing financial statements.

Charles Campbell,

Auditor.

GENERAL BALANCE SHEET

December 31, 1930

Assets	1930	1929
Due from Members	$ 3,400.02	$ 4,682.62
Due from Sale of Publications	439.75	364.65
Due from Advertising	310.00	625.00
Due from A.R.A. Rail Investigations	758.88	974.51
Furniture and Fixtures	632.00	997.40
Gold Badges	47.50	51.25
Publications on Hand (estimated)	4,000.00	6,000.00
Manual (1929)	5,712.49	11,837.49
General Index	3,269.89	3,269.89
Extensometers	500.00	500.00
Investments (Cost)	40,785.89	40,785.89
Interest on Investments (accrued)	257.20	257.20
Cash in National Bank of the Republic	10,328.50	8,468.21
Petty Cash Fund	25.00	25.00
Total	$70,467.12	$78,839.11

Liabilities	1930	1929
Members' Dues Paid in Advance	$ 6,631.00	$ 6,545.00
Impact Test Fund (Electrified Railways)	....	285.46
Due for Printing 1929 Manual	....	10,406.46
Advance Payments for 1929 Manual	....	2,442.80
Advance Payments for Advertising	....	20.00
Surplus	63,636.12	59,139.39
Total	$70,467.12	$78,839.11

The President:—The next order of business is reports of the Secretary and Treasurer. The Secretary will please present his report.

Secretary E. H. Fritch:—We have endeavored to present to you in brief form a record of the principal activities of your Association during the past year. Under the heading, "Committee-work," you will note a brief synopsis of the essential subjects reported on by the respective committees. As usual, committees have performed their duties with commendable zeal and thoroughness, and they are deserving of our thanks for their painstaking labors and the valuable contributions they have made.

To an ever-increasing extent the Association is being invited to cooperate with kindred organizations in the consideration of matters of mutual interest. A list of the associations, societies and joint committees with which we maintain cordial relations is given on page nine. From a review of the tables on pages ten, eleven and twelve, it will be noted that more than a third of the total membership of the Association participated actively in committee-work.

It is to be regretted that we are obliged to record a slight loss in membership instead of a gain during the preceding year. This condition may be attributed to the business depression prevailing in 1930. However, it is hoped and confidently expected to show a marked and substantial increase in membership a year hence. Classification of the membership on page thirteen is interesting, in that it indicates that railway officers connected with departments other than the engineering branch of the railway service find it advantageous to be affiliated with the A.R.E.A. The list of deceased members includes four Charter Members. Of the original 300 members composing the "Charter Members" only sixty are now on our rolls, the remainder having passed on to their reward.

It has just been brought to our attention that F. H. McGuigan, retired Vice-President of the Grand Trunk Railway System, a member of the first Board of Direction of the A.R.E.A., died on March 3, at the age of 81 years.

The world-wide distribution of the membership is shown on page sixteen. That the A.R.E.A. retains the good will and encouragement of railway managements to a marked degree is attested by the roster of Railway Executives whose affiliation we are privileged to record on page seventeen.

The railways represented in the A.R.E.A., their mileage, and the number of members on each road are shown in the table beginning on page eighteen.

The publications of the Association, the Bulletin, the annual volume of Proceedings, and the Manual, are the mediums through which the Association promulgates its activities and actions. The Bulletin is the "Advance Agent," the Proceedings constitute the permanent record of its activities and final action, and the Manual is an exemplification of what the Association considers the best current practice for Railway Engineering.

The financial statements appended to the report indicate that the Association has come through the industrial depression in a satisfactory condition.

The miscellaneous subjects refer to the joint investigation to be undertaken by the Rail Committee and rail manufacturers on imperfections in rail steel; result of the letter-ballot on the proposed amendment to the Constitution (relative to membership qualifications); and an interesting item of exceptional committee service records.

At this point it is desired to add the names of five members who have rendered long and distinguished services on the Committee on Iron and Steel

Structures, ranging in terms from 24 years to 19 years, namely, Dean F. E. Turneaure, O. E. Selby, Albert Reichmann, F. O. Dufour, B. R. Leffler.

Then, appointment of Reporters to the International Railway Congress to be held in Cairo, Egypt, in 1933; and, finally, an acknowledgment of faithful and conscientious services rendered by the office staff during the past year.

The report of the Treasurer, showing receipts and disbursements, and report on the stresses in track fund, is given on page 25.

Mr. President, I desire to offer the following resolution: "Resolved, that the reports of the Secretary and of the Treasurer be approved."

Mr. Edwin F. Wendt (Consulting Engineer):—I second the motion.

The President:—You have heard the motion. It has been seconded. Is there any discussion? If not, those in favor will please say "aye"; contrary, "no."

It is so ordered.

The President:—We have, as you know, quite a long program, and while we have urged the systematic presentation of discussion, I feel that there is ample time for thorough discussion of our reports and the other business of the convention.

We now come to the consideration of the reports of the Standing and Special Committees. The first report to be presented is that of the Special Committee on Standardization. The Committee will please come to the platform and the report will be presented by Mr. J. C. Irwin, Valuation Engineer of the Boston and Albany Railroad, the Chairman of the Committee.

(For Report, see pp. 112–118).

The President:—The Committee on Stresses in Railroad Track will please come to the platform.

The Chair will appoint the following members as a committee of tellers to canvass the votes cast for officers for the ensuing year: **B. B. Shaw, Chairman**; H. E. Silcox, C. M. Bardwell.

The Secretary will turn over the ballots to the tellers who will canvass the vote and be prepared to report just before the end of the afternoon session.

Dr. A. N. Talbot, Chairman of the Committee on Stresses in Railroad Track, will now present the report on this important subject.

(For Report, see pp. 205–206).

The President:—Until I reached the Secretary's office yesterday morning I had fully expected that we would have Mr. Aishton, President of the American Railway Association, make a short address to us this morning, but on arriving at Mr. Fritch's office I received the following letter:

"My dear Mr. Brooke: Fate seems to be against me as was the case last year in preventing me from being with you at Chicago during the annual convention of the American Railway Engineering Association, Division IV—Engineering. There are important hearings at Washington during all of next week which I feel absolutely obliged to attend and which prevent my leaving the city.

"I had hoped Mr. Gormley might be able to attend in my place but he has been obliged to go to Oregon to witness the concluding air brake test which will be under way during the week of March 8. I am therefore going to ask your indulgence to permit Mr. H. G. Taylor, Manager of Public Relations of the Car Service Division, to represent Mr. Gormley and myself at your meeting, and I am sending with him a message to your members, with the hope that you may be able to place him on your program sometime during the forenoon of March 10, as he is obliged to return to Washington at noon on that date.

"To you, Mr. President, to your committeemen and members, I send my keen regrets and best wishes and I trust that you may have a pleasant and profitable meeting."

Mr. Taylor is present and we should be glad indeed to hear from him at this time. I take pleasure in presenting Mr. Taylor (Applause).

Mr. H. G. Taylor:—Mr. President and Members of the Association: I can read in your faces evidences of your disappointment in the inability of Mr. Aishton to be here this morning, and likewise Mr. Gormley. I know that Mr. Aishton's regret over his inability to be present was sincere.

Of course it is always embarrassing to perform as a substitute. My position is illustrated by the incident in the Sunday school when they were preparing for the visit of the district superintendent. The teacher had been training the members of the boys' class to answer expected questions. Little Jimmie was to answer the question, "Who made you?" by saying, "God," and another little boy was to answer with the phrase, "Out of the dust of the earth," and so forth.

The day came when the district superintendent arose and put the first question to the class, "Who made you?" He waited a moment and then repeated the question. There being no answer, the situation became a little embarrassing. Finally, one of the boys in the class said, "Mr. Superintendent, the little boy that God made is home with the measles."

The little boy that God made in this instance is not home with the measles, but he is home all broken out with engagements and work which prevent his presence here at this time.

If you will indulge me for just a personal word, I do appreciate the opportunity of appearing before a group of Engineers. I have always envied Engineers because while to most of us mortals is given that rare privilege of dreaming dreams and seeing visions, it always seemed to me that the Engineer could dream dreams and then make them come true. Out of the creative capacity of his mind and imagination he pictures many things and then has the rare privilege of not only tracing those things on a blueprint but seeing them realized later on in stone and mortar, in structures and roadway, and in seeing them become real contributions to human progress. Since research engineering has become the religion of industry, it seems to me that the Engineer is occupying a much broader and more important field than ever before in his history.

Charles Kettering of General Motors says, you know, that it is the function of the Research Engineer to make people dissatisfied with what they have. We will concede that in the last decade they have succeeded very admirably in discharging that function. Indeed, the developmnets of research in every line of industry crowd upon us with such rapidity that they bewilder and mystify us as we attempt to apply our knowledge to current problems.

In no field has there been more marked evidence of this than in the transportation field. The Research Engineer with an insistent and irresistible urge has been developing new ideas, new means of transportation until today the country is crowded with new forms of transport that present problems, of intense interest and importance to all of us.

So the Engineer in railroad service today probably has as many problems as ever before in the history of that form of transportation, and yet I imagine he welcomes them because without problems we would not need Engineers.

Now to the word that Mr. Aishton has sent. It was my privilege to hear him dictate these remarks, and as his eyes flashed and his finger thumped the desk I knew he visualized this audience, that he could see many of you, most of whom he knows personally, and that as he dictated these words he was in effect delivering them directly to you. I trust I may be able to transmit them without too much static or other interference.

He says: "It is a good thing always for an individual, an organization or an association to take stock of itself. We are all too prone to get into a rut, to regard past precedent as our guide for the future, to display inertia about trying new experiments and all that kind of thing and, while adversity to all of us is a hard experience yet it has some compensations. Shakespeare, even in his day, very well said:

'Sweet are the uses of adversity,
Which like the toad, ugly and venomous,
Wears yet a precious jewel in his head;
And this our life exempt from public haunt
Finds tongues in trees, books in the running brooks,
Sermons in stones and good in everything.'

"I am not at all sure, speaking about association matters, but that this is the time that we should take serious stock of what we are undertaking and determining whether it is on effective lines, and by effective lines I mean lines that produce a definite result, or whether there are not other fields to which we could to advantage direct our attention.

"We are in a quickly changing world, particularly in the transportation field. In 1928 I made this statement, that there were three eras in the history of the railroads; first, the constructive period, the era of building, and expansion; second, the constrictive period of intense regulation, and I am not going into the reasons, causes for or objections, if there are any, to this regulation, but you all know what it was and what brought it about; and, third, the cooperative period, and this refers to the post-war period, particularly those years between 1923 and 1928 and, for that matter, is still progressing on the lines established in which movement voluntary associations like your own did a most valuable work.

"Since I made the statement in 1928 (and this is not an original thought at all, simply quoting what a number of prominent railway officials had been saying), there is a fourth period developing. There is the period of expansion into new forms of transportation required by the growth and progress of business, and the necessity for the most economical distribution. This is brought to the fore by these new forms of transportation, and it is all represented in the one word 'Coordinated.' In other words, you have the four C's representing periods of railroad history: constructive, constrictive, cooperative and coordinated, and it is this to which I direct your attention, and that of the other Divisions and Sections of the American Railway Association to the end that no field for this coordination be left unexplored or undeveloped.

"Never, in my judgment, has there been a time when there was more necessity for earnest and active study directed on lines that will thoroughly explore, analyze and dispose of any question that leads to greater economy in costs, to greater efficiency in service and to the greatest amount of coordination of all forms of transportation, in a complete whole, than the present. If this

is accomplished the public may reap the benefits of service at the lowest cost possible, with equal opportunity for every form of transportation to prosper and without prosperous transportation companies the whole national machine is unable to properly function.

"Some question, no doubt, has been raised in some of your minds as to the attitude of the railways toward this voluntary work. All that I can say about that is contained in the old saying, 'By their fruits ye shall know them' which I believe is in the Good Book, although I am not entirely sure. This applies not only to individuals and corporations but also to voluntary associations. It is not the tree and its branches and all that kind of thing that tell the story. It is what the tree, by careful cultivation and by careful pruning, bears in the way of fruit.

"In a time like the present when not only the railways but every line of industry has to readjust itself, I have indicated the advisability of:

"1. Securing, at points where the least amount of time and travel will be consumed in getting to meetings, as large an attendance as possible of committee members and others of the organization.

"2. Confining the time of meetings, as nearly as is practicable, to the earnest consideration of these serious problems that lay before you, because if there ever was a time when conclusive action was needed on these things that lead to better service, greater economies, greater efficiencies and all that kind of thing, this is the moment.

"I do not want you to feel that I am dealing with platitudes. I am dealing with a real live subject, a subject that is not only uppermost in the minds of the Railway Executives but also in the minds of the regulating bodies, and on the answer furnished is going to depend in a very large measure the future of the railways in the transportation scheme.

"I am an optimist. Nobody can make me believe that the railroads of this country are not going to continue to be the main stay of transportation, nor that the American people, in the final analysis, are not going to be favorably disposed toward and assist in the solving of the problems we are facing.

"Now one word about the A.R.E.A. or Division IV, Engineering, of the American Railway Association, because the two are synonymous. All you have to do is look at the Manual of your Association, containing the conclusions of your organization with respect to thousands of Railway Engineering questions. This is a veritable monument to the efficiency with which you have tackled and disposed of problems of every sort.

"It is considered by all railroads as authoritative on the subject it covers. It is, in effect, the bible of the Railroad Engineering man.

"I quote from the Foreword of the latest edition of the A.R.E.A. Manual:

"'This Manual is built upon, is validated by, and is the crystallization of 30 years of never-ceasing, recessless work of the Association through the perpetual investigations, studies, reports and recommendations of the Association committees on subjects definitely and annually assigned in the Association's outline of work by the Board of Direction.

"'The scope and quality of the work of the Association and the broad foundation upon which the Manual is built are revealed in general in the Constitution and in particular in the published Proceedings of the Association, now numbering 30 volumes, containing 30,000 pages of Committee reports and findings and Association conclusions and actions covering thirty years of highly concentrated work, there now being 23 Standing and four Special Committees composed of a total of 950 Committee members actively participating in com-

mittee-work. In addition, there is the unrecorded but large and invaluable work of the membership at large which collaborates definitely with the Committees individually in the making of their investigations, studies and reports. Individually and collectively, these builders of the Manual are highly trained and widely experienced in the subject-matters covered by the Manual. The conclusions and recommended practice of the Manual of the American Railway Engineering Association are, therefore, authoritative and dependable cross-sections of the composite judgment of men who build, maintain and operate railways.'

"Obviously such a compendium of valuable information could be made available in no other way than through the activity of a railway association. No one in their right mind would question the value of such activity. As President of the American Railway Association, with which the American Railway Engineering Association became allied some years ago, I would be the last person on earth to wish to detract one iota from the efficiency and effectiveness of any of its component parts. It occurred to me that, while the railroads, along with other business, are experiencing what we all hope will be a soon-ended depression, the time was appropriate for any experiments which look toward economy.

"I hope that what I may have said will leave this thought in your minds as to the attitude of the railways, which I am simply expressing for them, and that is it would be a misfortune for anything to be done that would jeopardize the valuable work which your Division and the other Divisions and Sections of the American Railway Association have been performing. Its very necessity insures a continuation of this work.

"It is my prediction that the experiment your General Committee of Direction has inaugurated this year, and the results that you obtain from your meeting here, will go a long way in determining in your own minds what is necessary in this respect in the future. The decision in that respect will rest with the members, and I need not assure you that if in any way I can contribute to your work by suggested lines of action, by active personal assistance or otherwise, all you have to do is command me" (Applause).

The President:—While we regret the circumstances which prevented Mr. Aishton from being here, I am sure we thoroughly appreciate the message which he sent and particularly in having it delivered so ably by Mr. Taylor.

The Committee on Uniform General Contract Forms will please come to the platform. The Chair would especially urge that the newer and younger members of the Association participate actively in the discussions of the Committees' reports.

As the years go on, they will be required to fill in the gaps which may occur in the ranks of the Association, and there is no better time than the present for them to get into this very important phase of Association work. I hope they will take this to heart and let us hear from them.

This report will be presented by Mr. J. C. Irwin, its Chairman.

(For Report, see pp. 107–111).

(Vice-President J. V. Neubert in the Chair.)

Vice-President J. V. Neubert:—The next Committee will be on Clearances. The report will be presented by the Chairman, Mr. A. R. Wilson, of the Pennsylvania Railroad.

(For Report, see pp. 95–98).

Vice-President J. V. Neubert:—The next Committee is on Electricity. Will these gentlemen please come forward?

While this Committee is coming forward, which I wish they would do promptly, I wish to invite you to take part in the discussion. I know we are on a very tight schedule, but the Chair will recognize if you are over-imposing and getting on the other Committee work, but please do not be backward, particularly the young fellows, in opening discussion.

In the absence of the Chairman, Mr. Withington, the report will be presented by Mr. Brumley.

(For Report, see pp. 321–323).

AFTERNOON SESSION

The President:—The next Committee to report is that on Grade Crossings. The personnel will please come to the platform.

The report will be presented by the Chairman, Mr. Frank Ringer.

(For Report, see pp. 65–94).

The President:—The Committee on Ballast will please come to the platform. This Committee's report is found on page 99 of Bulletin 329 and will be presented by Mr. A. P. Crosley, the Chairman.

(For Report, see pp. 99–106).

The President:—The Committee on Ties will please come forward. This report will be presented by the Chairman, Mr. W. J. Burton.

(For Report see pp. 235–279).

(Vice-President J. V. Neubert in the Chair).

Vice-President J. V. Neubert:—The Committee on Wood Preservation will please come forward. The report will be presented by Mr. F. C. Shepherd, the Chairman of the Committee.

(For Report, see pp. 281–312).

Vice-President J. V. Neubert:—The next Committee is Iron and Steel Structures. The report is contained in Bulletin 330, page 119. This report will be presented by Mr. A R. Wilson, of the Pennsylvania Railroad, Chairman of the Committee.

(For Report, see pp. 119–134).

Vice-President J. V. Neubert:—The next Committee is Wooden Bridges and Trestles, contained in Bulletin 332, page 313. Will the Committee please come forward? The report will be presented by Mr. Austill, the Chairman.

(For Report, see pp. 313–319).

Vice-President J. V. Neubert:—Before I call the next Committee, I will ask Mr. Fritch, the Secretary, to give a report of the Tellers.

The Secretary:—The report of the Tellers is as follows:

We, the Committee of Tellers, report the following as the result of the count of the ballots:

For President:

L. W. Baldwin	1474 votes
W. P. Wiltsee	1 vote
J. V. Neubert	1 vote

For Vice-President:

W. P. Wiltsee	1468 votes
E. A. Hadley	1 vote

For Secretary:

E. H. Fritch ....1471 votes

For Treasurer:

A. F. Blaess ....1459 votes

For Directors (Three to be elected):

E. A. Hadley	937 votes
S. S. Roberts	715 votes
T. T. Irving	604 votes
A. R. Wilson	596 votes
Dr. Hermann von Schrenk	444 votes
J. C. Irwin	347 votes
W. C. Barrett	324 votes
C. H. Stein	225 votes
F. R. Layng	224 votes
J. A. Heaman	1 vote

For Members Nominating Committee (Five to be elected):

C. W. Baldridge	1026 votes
A. N. Reece	939 votes
G. F. Hand	812 votes
C. C. Williams	745 votes
R. T. Scholes	720 votes
E. M. Hastings	693 votes
W. D. Simpson	623 votes
W. G. Atwood	604 votes
C. H. Tillett	573 votes
S. T. Wagner	376 votes
Scattering	7 votes

(Signed) COMMITTEE OF TELLERS,
By B. B. SHAW, *Chairman.*

Vice-President J. V. Neubert:—The next Committee is the Committee on Maintenance of Way Work Equipment. Its report is contained in Bulletin 333, page 439. The report will be presented by Mr. C. R. Knowles, of the Illinois Central Railroad, Chairman of the Committee.

(For Report, see pp. 439–481).

TUESDAY EVENING SESSION

The President:—I will ask the Committee on Yards and Terminals to come to the platform. The report will be presented by the Chairman of the Committee, Mr. H. L. Ripley.

(For Report, see pp. 207–220).

The President:—The Committee on Shops and Locomotive Terminals will please come forward. The report of this Committee is found on page 483 of Bulletin 333. The report will be presented by the Chairman, Mr. L. P. Kimball.

(For Report, see pp. 483–500).

The President:—The Committee on Buildings will please come forward. Mr. A. L. Sparks, Chairman of the Committee, will present the report.

(For Report, see pp. 547–605).

The President:—The Committee on Roadway will please come to the platform. The report of this Committee is found on page 165, Bulletin 330. The report will be presented by the Chairman, Mr. C. W. Baldridge.

(For Report, see pp. 165–192).

WEDNESDAY, MARCH 11, 1931

MORNING SESSION

Vice-President J. V. Neubert:—Will the Committee on Signals and Interlocing please come forward? The report is contained in Bulletin 334, and begins on page 627. The report will be presented by Mr. W. M. Post, Assistant Chief Signal Engineer, Pennsylvania Railroad, who is Chairman of the Committee.

(For Report, see pp. 627–639).

Vice-President J. V. Neubert:—Will the Committee on Rules and Organization please come forward? This report is contained in Bulletin 330, page 135. The report will be presented by Mr. E. H. Barnhart, Industrial Engineer, Baltimore & Ohio Railroad, Chairman of the Committee.

(For Report, see pp. 135–149).

Vice-President J. V. Neubert:—The next Committee report is that on Records and Accounts, contained in Bulletin 333, page 501.

The report is presented to you by the Chairman, Mr. C. C. Haire, Auditor Capital Expenditures, Illinois Central System.

(President G. D. Brooke assumed the Chair)

The President:—We will now vary somewhat from the program to hear from the President of the American Society of Civil Engineers. The speaker had the very good fortune to start his engineering experience under a man from whom he could learn the highest ideals, the soundest engineering principles, steadfastness of purpose, and no misconception of the value of hard work. He is a member of this Association and while, because of conflicting engagements he has not been able to attend the recent sessions of this convention, he has shown his great interest in the work by coming all the way from New York to speak to us this morning.

You all know his record as well as I do; former Chief Engineer of the Erie Railroad; of the Baltimore and Ohio Railroad; member of the Council of National Defense, and now President of the American Society of Civil Engineers.

I take great pleasure in presenting Mr. Francis Lee Stuart.

(The convention arose and applauded.)

Mr. Francis Lee Stuart (President, American Society of Cicil Engineers):—It is a pleasure to be here. Before I start my address I want to tell you something about your President, George D. Brooke.

He came to me from college and soon began to hang around our field offices at night, helped in the office and showed other intelligent signs that his job was his life interest. He has been doing that ever since in his quiet way He has been filling every position on his way up and has always been ready to take the next thinking job. He never was a flash in the pan, an accident, and he did not climb over the shoulders he should have supported. He moved surely, steadily, and richly deserves the advancements he has received. It is a great pleasure to me to have seen him grow.

It is a great pleasure to me as President of the American Society of Civil Engineers to express their interest in you and your Association's work, and to wish you vigor and added power in your effort to make the American railway economics, practices and standards the best that Engineers can devise.

We feel that your efforts are advancing the esteem in which your profession of Civil Engineering is held, and we will be glad to help you and cooperate with you in any way possible.

I became a member of the A.R.E.A. in its early stages and was a working member on committees until I made way for others, but I was so impressed with its possibilities to improve Railway Engineering that I, more than twenty years ago, prevailed upon the Erie Railroad, and afterwards the Baltimore & Ohio and other railroads, to send their men to its meetings and to pay their expenses.

As I look back on what you have done, I think that money gives the best return per dollar expended by the railroads that I know of. It is very encouraging to note the wonderful effect the earnest work of the A.R.E.A. men have had. They collectively have had the privilege to co-ordinate previous practices and with their contributions they have brought about the standardizing of the best railroad practice, and the dissemination of such knowledge to every employee of every railroad in every part of the world; and it has made railroading in the lines so far covered by the A.R.E.A. an art for Americans to be proud of. Every man who has done his part should feel rewarded by their accomplishment and be eager for further thinking as Engineers along the lines in which I hope to see you progress.

There is today an urgent demand for clear thinking by you and men like you in upbuilding and advancing our country's lagging prosperity. Individual reward for initiative and energetic effort has made our country great. This very incentive has been rewarded by such continued prosperity that the herd instinct and avarice of man has run wild with our judgment and greatly aggravated world conditions and brought on us all an unwarranted period of stress and strain.

Unemployment of all classes runs into hundreds of thousands in various parts of the country and the Federal Government, State and Industry are jointly trying to meet that situation, and the Engineers of the country as you know are daily doing their very important part in such wideflung efforts in the wholehearted and creditable way we have a right to expect.

I just digress to tell you that early last fall one of the first decentralizing efforts of the Woods Committee was assisted by the appointment of 150 Engineers all over the United States who are members of the American Society of Civil Engineers.

The urgent question for all is what should be done to permanently improve these depressing conditions in this country and abroad. No one can give a full formula to prevent a recurrence of present troubles, but one of the most important and helpful forces for permanent recovery would be the dissemination of knowledge with a display of the red lights of danger in such a forceful way that all must look and listen and heed, and thereby cause a voluntary regulation of the surpluses of mass production and also cause a diversification of efforts so as to meet the needs of our probable markets and to demand a political policy of reciprocity to broaden these markets.

Present conditions are distressing in these lines for the moment, but should improve quickly as our political diseases are cured and our internal and world affairs are modernized, and the experience may be of lasting benefit to all if it changes our mental slant as to our relations to world affairs and our permanent prosperity.

All human beings of whatever race and nationality are created with mental possibilities and susceptible of degrees of education and ambition. Yet two-thirds of the population of the globe are living on a scale that should be of grave concern to our Twentieth Century civilization and are one of our unavoidable responsibilities.

In this country of ours with an abundance of the necessities of life and a surplus of the products of industry and the mentality to meet any worldwide competition in farm produce, industry and transportation, there is no excuse for an economic policy which permits five million men to be out of employment, while two-thirds of the world needs and will want our wares for generations to come for improving living conditions and by past experience must, in fact, have them or by stagnation be absorbed or perish.

In the early stages of our industrial life, when education and immigration developed our chief consumers, a protective tariff probably speeded our progress, but the remedy now, I feel, is to call a halt on the present haphazard tariff policy and its financial fallacies and cause a scientific application of a worldwide distribution of properly regulated surpluses founded on a flexible scheme of world reciprocity and a co-ordinated flow of credit to prevent abuses.

What is more, I believe reciprocity is as necessary a medium for the politically diseased abroad as it is for us, and that it would assist all in maintaining and improving our living standards.

I feel sure that pioneering with Reciprocity, by which I mean give and take in trade, and pioneering with Education, by which I mean the spreading of the knowledge of the mental pleasures as well as the physical pleasures our standards of living afford, in those sections which compose two-thirds of the world which is lagging behind our civilization will help us towards permanent relief.

As to the local affairs and the railroad problems which confront us in our internal relations with our own people you might help by bringing your powers for engineering thought or research to bear on such subjects as to the railroad's relation to other competitive means of transportation such as water service and truck and bus service and private automobile.

Water service (exclusive of lake and ocean) has its inherent limitations which Government aid or other efforts cannot keep out of the picture. It has but few points of production and distribution local to any particular canal or river facilities in question and for all other business not local to such facilities there is an extra cost of the transfer to and from railroads at the water terminals at each end and such service cannot become of great moment in the railroad situation.

As to truck service—just as the railroad has the advantage of car access to countrywide collecting and distributing points without the two transfer costs above which are necessary in water borne traffic en route to points not local to the water service, so the truck, within limits of its economical use for main road haul, has the advantage of store-door delivery to innumerably more

points of collections and delivery without the transfer to trucks at both ends as are required by rail service to the same points.

Government subsidy of free roadbed for truck purposes can at best only lengthen the economical length of main line haul and cannot change the inherent flexibility of the service which is the real competitive feature the railroads have to meet. With this in mind for at least ten years, Engineers have been urging the railroads to use containers and make store-door deliveries as a gradual transition to the time when they must operate the truck service themselves where economically possible.

The bus situation is a different matter and one of costs, and each route needs a careful comparative study of rates and facilities. Its disabilities, except for street traffic, are discomfort and waste of time mentally and safety risks of driver and factors beyond his control.

Inasmuch as the public is entitled to and should have the cheapest and best means of transportation, which will do the country as a whole and the people the most good, these competitive means of transportation are entitled to their just places, but it must be remembered that our railroads are the heart and the backbone of our daily traffic and must not be crippled by preferred treatment at its expense, to water and truck which would be impotent to handle all our traffic or any considerable part of it and cannot take the place of the railroad's service.

Coming out to Chicago, I passed many trains with 4000 and 5000 tons behind one engine, and I could not help but feel that it was a dangerous policy to gradually whittle away the revenues of such an agency, and we must stop it if we can.

While not at present serious, it seems proper to call attention to the fact that not satisfied with expenditures for subsidies for actual building canals and river channels, which may or may not be wise, but often is used to bolster up political fences, by Congressional order such facilities are used for rate-making purposes, to drive business to use such water service, and the railroads are compelled to join in same and the revenues are being reduced by such diversion of its business. The artificial stimulants which will be used to create waterways activity are full of potential trouble and should be a matter of concern.

It seems proper to also state clearly that in addition to building free roadways out of taxes for trucks and buses, which may or may not pay their due share in taxes, our lawmaking bodies at present allow trucks to perform the services of common carriers without any of the regulations that the railroads as common carriers have to meet. By such lack of regulation the trucks can pick and choose their freight, and take it when and where they find it profitable and leave what they do not want to the railroads, all of which takes away more gross revenue from the railroads without resulting economies.

The railroad facilities and lack of facilities are regulated by the Interstate Commerce Commission and it is their duty to see that the railroads furnish all the transportation service that the whole country will need, so that the railroads are required to keep facilities and equipment necessary for a 100 per cent business while they are at times on account of such inroads estimated to be only getting 80 per cent of the business.

For example, Smith may use a truck doing a common carrier business without regulation five days in a week and the sixth, if there is too much snow, he may carry such freight to the railroad and if it was not handled properly and promptly, lodge a complaint with the regulative body. Likewise, Mrs. Brown may find it too cold in a bus doing a common carrier passenger business without regulation and the five-fifteen must carry enough coaches to give her a seat or she may request that the four-fifty be put back in their schedule. Even Smithtown and Brownsville could not use buses and trucks if they did not have the railroads to fall back on.

I have taken the trouble to set this matter out in detail to show you what a mirthless joke it is for our own lawmakers to stand by while the regulatory powers practically require the railroads to hold facilities and equipment to guarantee the service of the unregulated trucks and buses while such competitive service takes away possibly 10 per cent to 30 per cent of railroad revenue.

The statement of the problem points to the answer. The truck is here to stay, and we will have to go into the truck and bus business to protect our interests, and you should be thinking it over.

As to the private automobile, it is such a great civilizer and agency for improving living conditions that it is worth what it cost us; however, it has been a large factor in our unemployment situation and should be studied to prevent a recurrence.

The opportunity for research in the railroad field is a fertile subject and should be pushed. We have a rate structure which has no simple, rational basis and should have a real scientific study made by a technical body and should be taken out of the mystery class. I feel the period of cheap grade reductions is about over and we must look to re-routing by consolidations for greater economies in that direction. We must also look to economies by reducing resistance of rolling stock and increase efficiency of fuel consumption.

The views herein are my own and only of such value as they appeal to your minds and set in motion trains of thoughts which will find the truth and inure to the benefit of the railroad business, which is your life work.

The National societies, such as the American Society of Civil Engineers, are for the purpose of helping all Engineers in their relation to each other and all the technical branches of the profession and to encourage a fellowship of men. They are what we make them and are the best tools we have for the purpose. They deserve every Engineer's support.

Technical society records are their great collective contribution to coming generations and your part in such records as those of the A.R.E.A., which are probably the most useful to have in print for the subjects treated, will always be a satisfaction to you as you see the effect they have on the railroads of the future.

In conclusion, let me repeat to you what I have said before: Technical societies and universities and libraries in a broader sense have been forming, developing and recording for posterity the educational thoughts and forces which have been advancing our civilization.

These educational agencies have kept currently available our knowledge of Engineering which has prepared the way and enabled us and other Engineers to make advances in the art of living which will cause the present hundred years to be known in history as the Engineering Age.

The world at large, and even we, ourselves, have just begun to realize the growing importance of our professional place in the scheme of life as it is today. I believe that the influence of Engineering in the history of this age is so great that we can rightfully feel elation and encouragement as we move forward to meet the responsibilities of the future.

(The audience arose and applauded.)

The President:—I want to express my keen personal appreciation for the kind references to me by Mr. Stuart, and the deep appreciation of this Association for his splendid, timely address to us.

The Chairman of the Records and Accounts Committee will now present the report of that Committee.

(For report, see pp. 501–546).

The President:—The Committee on Masonry will now come to the platform. Mr. C. P. Richardson, Engineer of Track Elevation, Chicago, Rock Island & Pacific Railway, Chairman of the Committee, will present the report.

(For Report, see pp. 325–344).

The President:—Will the Committee on Rivers and Harbors please come forward?

At this point in the program, while this Committee is assembling, we will give an opportunity to Mr. Haggard, who is in charge of the section of Civil Engineering Works Exhibit of "A Century of Progress" to make three minutes' remarks. Mr. Haggard.

Mr. Ashley P. Haggard (A Century of Progress):—Mr. President, Directors, Members of the American Railway Engineering Association:—"A Century of Progress" wishes to express its appreciation for the courtesy of your President in allowing our representative to have the honor of addressing your membership.

"A Century of Progress" invites the American Railway Engineering Association to meet with the members of staff individually or collectively, when convenient to do so, prior to the opening of the World's Fair.

"A Century of Progress" is the executive unit set up to carry out the recommendations of the National Research Council and the Science Advisory Committee. The recommendations cover every phase of human endeavor during the past century to be demonstrated in the World's Fair to be opened here in Chicago on June 1, 1933, for 150 days. The National Research Council and the Science Advisory Committee with "A Century of Progress" will display to the world the most magnificent display of the achievements of mankind.

Gentlemen, the set-up as far as the Engineering Section of "A Century of Progress," as represented here to-day by myself, is as follows: Backing me is the Division of Applied Science and Industry with all its liaison with individuals who can assist in industry to put on that branch of the show. Over and above them is the Department of Exhibits backed by the entire organization of "A Century of Progress" composed of 75 trustees of the City of Chicago, the most prominent and wealthy men in this section. Mr. Rufus Dawes is the President of the organization. The organization of "A Century of Progress" is not for profit.

Our staff, with the Science Advisory Committee of the National Research Council (which Council, by the way, is an effective organization formed for

the purpose of solving engineering scientific problems or whomsoever in the world it considers worthy. The first time it came into existence was at the request of Abraham Lincoln to solve the major problems and bring the Civil War to a close. The second time it came into existence was at the request of President Wilson to solve, and did solve, many of the problems that permitted us to end the World War.

This organization, approached by our directorate of "A Century of Progress" through General Charles G. Dawes, our Ambassador to Great Britain, consented because of the scientific displays and the educational features that will be shown here in the World's Fair, to advise "A Century of Progress" and suggest the scenario for this show. With the set-up which tomorrow could bring into existence over 8,000 of the most brilliant minds in the United States, there is no question about whether or not the World's Fair will be held here in Chicago on June 1 in 1933. It will no doubt be the most magnificent educational endeavor in the history of the world. It will give the scientist, the layman and the children the chance for the first time to see what has been achieved in the past century. It will show the last-minute results of invention and scientific endeavor, and then will proceed to show to the generation, that will be in command of the situation in the next century, ways and means and necessary approaches for progress.

If you gentlemen, before you leave the City of Chicago, can find time to visit "A Century of Progress" at the Administration Building set up in Burnham Park near Soldier Field, we would be pleased to meet you individually or collectively.

I wish to thank your President and this membership for allowing me to have the honor of addressing this meeting. Thank you. (Applause)

The President:—Mr. E. A. Hadley, Chief Engineer, Missouri Pacific Railroad, Vice-Chairman of the Committee, will present the report of that Committee.

(For Report, see pp 607–626).

AFTERNOON SESSION

The President:—The first report this afternoon is that of the Committee on Economics of Railway Location. Mr. F. R. Layng, Assistant Chief Engineer, Bessemer & Lake Erie Railroad, Chairman of the Committee, will present the report.

(For Report, see pp. 221–234).

The President:—The Committee on Economics of Railway Labor will please come forward. The report is found in Bulletin 330, page 193, and will be presented by Mr. F. M. Thomson, District Engineer, Missouri–Kansas–Texas Lines, who is Chairman of the Committee.

(For Report, see pp. 193–204).

The President:—The Committee on Water Service and Sanitation will please come forward. The report will be presented by the Chairman, Mr. R. C. Bardwell, Superintendent Water Supply, Chesapeake & Ohio Railway.

(For Report, see pp. 399–438).

The President:—The Committee on Rail will please come forward. The report will be presented by Mr. Earl Stimson, Chief Engineer Maintenance, Baltimore & Ohio Railroad, who is Chairman of the Committee.

(For Report, see pp. 345–398).

The President:—The Committee on Track will please come to the platform. I shall ask Mr. Yager, Past-President, to take the Chair.

(Past-President Louis Yager in the Chair.)

Past-President Louis Yager:—You will find the report of this Committee in Bulletin 330, beginning on page 150. The report will be presented to you by Mr. J. V. Neubert, Chief Engineer Maintenance of Way, New York Central Railroad, who is Chairman of the Committee.

(For Report, see pp. 150–164).

Past-President Louis Yager.—Will the Committee on Economics of Railway Operation please come forward? The report will be presented by Mr. J. E. Teal, Special Engineer Operation, Chesapeake & Ohio Railway, who is Chairman of the Committee.

(For Report, see pp. 641–701).

(President G. D. Brooke resumed the Chair.)

The President:—Gentlemen, the presentation of Committee reports is now complete. The next thing before us is "New Business." Is there any new business to come before the Association?

The Secretary:—I have a communication, Mr. President, from the United States Commission for the Celebration of the Two Hundredth Anniversary of the Birth of George Washington, signed by the Associate Director:

"For the consideration of your organization at its forthcoming convention the United States Commission for the Celebration of the Two Hundredth Anniversary of the Birth of George Washington, requests your endorsement of the Celebration in 1932, and invites your moral support and cooperation in doing your share to make it all that it should be.

"An account of the origin, purpose and plan of the commission is submitted, together with the personnel, which is headed by the President of the United States.

"The Commission is anxious to enlist the full collaboration of every organization, business house, church, school and home in this great republic and is relying upon the interest and support of your members, individually and collectively. In order that formal expression may be given your attitude in this matter, would it not be possible to secure passage by your organization of some such resolution as that enclosed."

The suggested resolution is as follows:

"Whereas, The Congress of the United States has created a Commission to arrange a fitting nation-wide observance of the Two Hundredth Anniversary of the Birth of George Washingtin in 1932; and

"Whereas, The Commission so created, composed of the President of the United States, the Vice-President of the United States, the Speaker of the House of Representatives, four members of the United States Senate, four members of the House of Representatives, and eight citizens appointed by the President of the United States, is charged with the duty of planning and directing the celebration; and

"Whereas, The high purpose of the event is to commemorate the life, character and achievements of the most illustrious citizen of our Republic and to give every man, woman and child living under the Stars and Stripes an opportunity to take part in the celebration which will be outstanding in the world's history; and

"Whereas, The George Washington Bicentennial Commission, desiring the full cooperation of the people of the United States, has extended a most cordial and urgent invitation to our organization to participate in the celebration; therefore, be it

"*Resolved,* That the American Railway Engineering Association does hereby endorse the program of observance of the Two Hundredth Anniversary of the Birth of George Washington, to take place in 1932; accept with appreciation, the invitation of the George Washington Bicentennial Commission, and

pledge this organization to extend earnest cooperation to the United States Commission in all possible ways, so that future generations of American citizens may be inspired to live according to the example and precepts of Washington's exalted life and character, and thus perpetuate the American Republic; and be it further

"*Resolved,* That this resolution be incorporated in the official proceedings of this meeting and that a copy thereof be transmitted to the George Washington Bicentennial Commission, Washington, D. C."

The President:—You have heard the proposed resolution, gentlemen. What is your pleasure?

Past-President D. J. Brumley:—I move the adoption of the resolution which Mr. Fritch read.

Past-President Louis Yager:—I second the motion.

The President:—Is there any discussion. If not, those in favor of the adoption will say "aye;" contrary, "no." It is carried.

Past-President D. J. Brumley:—I move the adoption of the following resolution:

"*Resolved,* That the members of the American Railway Engineering Association in convention assembled desire to place on record their hearty appreciation of the most excellent manner in which this convention has been presided over by Mr. George D. Brooke, and for the efficient administration of the affairs of the Association during his occupancy of the presidential chair.

"*Resolved,* That this resolution be spread upon the Minutes of the meeting and that a suitably engrossed copy be presented to Mr. Brooke."

Past-President Edwin F. Wendt:—I second the motion.

Past-President D. J. Brumley:—You have heard the motion, which has been duly seconded. This question is not debatable. Those in favor of the motion will say, "aye." There are no noes (Applause).

The President:—Gentlemen, I thank you.

Mr. C. J. Geyer (Chesapeake & Ohio):—I have the following resolution to submit:

"*Resolved,* By the American Railway Engineering Association, in convention assembled, that its appreciative thanks are hereby extended to the National Railway Appliances Association for the interesting and instructive exhibit of railway devices and appliances; to the Palmer House and its management for the facilities afforded the Association."

The President:—You have heard the motion, gentlemen. Is there any discussion? If not, those in favor will say "aye;" contrary, "no." The motion is carried.

Mr. Frank Ringer (Missouri–Kansas–Texas Lines):—I desire to move the adoption of the following resolution:

"*Resolved,* By the American Railway Engineering Association, in convention assembled, that its thanks are hereby extended to the chairman, vice-chairman and members of the several committees for their labors during the past year and for the valuable reports presented."

The President:—You have heard the motion, gentlemen. Is there any discussion? If not, those in favor will please say, "aye." Contrary, "no." It is carried.

Mr. C. C. Cook (Baltimore & Ohio):—I move adoption of the following resolution:

"*Resolved,* By the American Railway Engineering Association, in convention assembled, that its thanks are hereby extended to Mr. Francis Lee Stuart,

President of the American Society of Civil Engineers, for the very interesting and instructive address on the morning of March 11th, and for the expressions of good-will to the members of the American Railway Engineering Association from the American Society of Civil Engineers, which the A.R.E.A. fully reciprocates."

The President:—You have heard the resolution. Those in favor will please say, "aye." Contrary, "no." The motion is carried.

Mr. Edwin F. Wendt (Consulting Engineer):—Mr. President, I would ask that Mr. George J. Ray come forward.

Mr. President, it is fitting that this Association pause a few moments in its proceedings in order to express its appreciation of the work which has been done by George J. Ray, who is about to graduate from the Board of Direction. He has served for eleven years in the positions of Director, Vice-President, President and Past-President.

His graduation means a commencement of an even greater work in behalf of the Engineering profession.

It is my pleasure in behalf of the Board of Direction and members of this Association to present to Mr. Ray a medal. On one side of the medal are four figures—Time, Industry, Ability and History.

He has had Time to demonstrate Industry and Industry has crowned Ability and History has made a record of his achievements.

On the opposite side of the medal are figures of two trees, the laurel and the oak, the one representing Honor, the other Strength. Beneath these trees appear the words, "Awarded to George J. Ray in recognition of his outstanding ability as a Railway Engineer, a Past-President of this organization."

Mr. Ray, it is one of the greatest pleasures of my life to present to you this medal in recognition of the honor in which you are held by the members of this Association.

(The audience arose and applauded.)

Past-President G. J. Ray:—Mr. Wendt, Mr. President and fellow-members of the American Railway Engineering Association:—I want to assure you that this medal is appreciated very much. I only can say that whatever I may have done to help with the work of this Association is nothing compared with the benefit that I have personally received through my association with the fellow-members of the American Railway Engineering Association. I shall always cherish the memory of my connection as an officer and a member of this Association. I thank you most sincerely (Applause).

The President:—Are there any further resolutions to be offered?

Mr. Mott Sawyer (Chicago, Milwaukee, St. Paul & Pacific):—I wish to move the adoption of this resolution:

"*Resolved,* By the American Railway Engineering Association, in convention assembled that its thanks are hereby tendered to Mr. R. H. Aishton, President of the American Railway Association, for his courtesy in sending his representative, Mr. H. G. Taylor, with a message of encouragement from the American Railway Association on the morning of March 10th."

The President:—You have heard the resolution, gentlemen. Those in favor will please say "aye"; contrary, "no." The motion is carried. Are there any further resolutions?

Mr. C. A. Knowles (Chesapeake & Ohio):—I desire to offer the following resolution:

"*Resolved,* By the American Railway Engineering Association, in convention assembled, that its thanks are hereby extended to Secretary Fritch and his staff for the efficient manner in which the affairs of the Association were conducted during the past year."

The President:—You have heard the motion, gentlemen. Those in favor will please say "aye"; contrary, "no." The motion is carried.

Any further resolutions? If not, I want to take this occasion, gentlemen, for the Association and for myself personally to thank the retiring Directors for the wholehearted support, the able assistance and the wonderful work they have done as members of the Board for this Association.

I would also like, on my own behalf, to thank all of the officers of the Association, the Secretary and his staff, the Board of Direction, all the Chairmen of Committees, in fact every member of this Association, for the wonderful support they have given the officers and me personally during the past year.

We have had to carry on part of the year's work under unusual conditions, but the results are gratifying. The attendance at these sessions has been particularly good. I appreciate deeply your hearty support and cooperation.

I thank you.

Is there any further new business? If not, the Secretary will again announce the result of the elections of officers for the ensuing year.

The Secretary:—The officers elected for the current year are:

President:—L. W. Baldwin, President, Missouri Pacific Lines. (Applause)

First Vice-President:—J. V. Neubert, Chief Engineer Maintenance of Way, New York Central Railroad. (Applause)

Second Vice-President:—W. P. Wiltsee, Chief Engineer, Norfolk & Western Railway. (Applause)

Secretary:—E. H. Fritch. (Applause)

Treasurer:—A. F. Blaess, Chief Engineer, Illinois Central System. (Applause)

Three Directors:—E. A. Hadley, Chief Engineer, Missouri Pacific Railroad; S. S. Roberts, Assistant Director, Bureau of Finance, Interstate Commerce Commission; T. T. Irving, Chief Engineer, Canadian National Railways. (Applause)

Five Members of the Nominating Committee:—C. W. Baldridge, Assistant Engineer, Atchison, Topeka & Santa Fe; A. N. Reece, Chief Engineer, Kansas City Southern; G. F. Hand, General Assistant Engineer, New York, New Haven & Hartford; C. C. Williams, Dean, College of Engineering, University of Iowa; R. T. Scholes, Assistant to Chief Engineer, Chicago, Burlington & Quincy Railroad. (Applause)

The President:—Mr. Baldwin, my two immediate predecessors have instituted the very appropriate custom of presenting to the incoming President a gavel as a memento of his tenure of this office.

I hold here in my hand a gavel made of young hickory from the timber lands of Springhill Farm, Anne Arundel County, Maryland. It was selected personally by Mrs. Cook, your sister, to whom and our mutual friend, Ralph Payne, I am indebted for procuring it. Of the same soil, of the same steady fiber as the Baldwins themselves, it gives me great pleasure to present it to

you and, with it, to turn over to you the Presidency of the American Railway Engineering Association. I congratulate you warmly, sir.

(The audience arose and applauded as President-Elect L. W. Baldwin assumed the Chair.)

President-Elect L. W. Baldwin:—First, I should like to say to you, Mr. Brooke, that I hope any use of this hickory gavel will never sting as my memory recalls some of it did on the Springhill Farm in Arundel County, Maryland (Laughter and applause).

Gentlemen, you have conferred upon me today an honor which I assure you is deeply appreciated. Knowing the responsibility, I should hesitate to accept this dignified position if I were not familiar with the excellent work that has been done and is being done by the officers, committees and membership of this Association. Knowing that Engineers have learned that application to work and intricate analysis of all subjects are necessary to success, and in appreciation of the cooperation you have given previous Presidents, it shall be my purpose to render every assistance to this Association, that it may go on, and with the hope and expectation that the work will continue to be a credit to the railroads of this country and to the Engineering profession.

I thank you. (Applause)

Mr. Fritch tells me that Mr. Safford has some duty to perform.

Past-President H. R. Safford (Missouri Pacific):—A few minutes ago this Association, by appropriate resolution, acknowledged and paid a tribute to the service which has just been given to us in the past year by our retiring President, Mr. George D. Brooke. That resolution will be suitably engrossed and will be a permanent suggestion to him of our affectionate loyalty and the tribute to the service that he has given this body for many years.

It would seem to be proper that we might supplement that expression by something of a more substantial nature, perhaps more appropriately representing our feeling.

Mr. Brooke has been an active man in this Association work for a long time. Those of us who have had the opportunity to attend many of these meetings have remembered his constant devotion to duty, his interest in the work, and the constructive service he has given throughout his association with this body.

It becomes my pleasant duty to present to him from the Association an emblem which is an appropriate and typical gift. It suggests, as it is a receptacle that is often used for sustenance, the fund of useful service he has always given. I think of it more than merely a cup. I think of it as typifying the widow's cruse which will always be filled with a loyal, constructive desire to serve. It will never be empty, I am sure, of that fund of effort which he has always given and always will give.

Its brilliancy suggests the character of work which he has done. It suggests his mental processes. It affords me great pleasure to present it and I know I represent the views of this entire membership when I present to him this little token of our sincere appreciation.

Mr. Brooke, this is given to you with all of the loyalty and affection that a body of men can have for one who has given so much to this body-work (Applause).

Past-President G. D. Brooke:—Mr. Safford, Mr. President, and my Friends of the Association: Into the professional life of each one of us I perceive there come certain outstanding events, certain occasions of the highest significance—occasions which may be counted as supreme. One such came to me a year ago when through your kind generosity I was made your Chief Executive Officer. Now you bring to me another such when through this indication of your regard you show me so well that my efforts during the past year have not been in vain.

Gentlemen, from the bottom of my heart, I thank you (Applause).

President L. W. Baldwin:—Gentlemen, if there is nothing more to come before the meeting, this convention stands adjourned.

(The meeting adjourned *sine die* at five-five o'clock.)

The Thirty-Second Annual Convention of the American Railway Engineering Association will be held at the Palmer House, Chicago, March 15, 16 and 17, 1932.

E. H. Fritch

Secretary.

COMMITTEE REPORTS

REPORT OF COMMITTEE IX—GRADE CROSSINGS

FRANK RINGER, *Chairman;*
H. E. BARLOW,
R. W. BARNES,
F. D. BATCHELLOR,
H. D. BLAKE,
J. E. BREEN,
J. G. BRENNAN,
H. E. BRINK,
C. W. CHARLESON,
S. N. CROWE,
L. B. CURTISS,
A. F. DORLEY,
G. N. EDMONDSON,
H. L. ENGELHARDT,
P. M. GAULT,
F. S. HALES,
RAY HENRY,
M. V. HOLMES,
A. G. HOLT,
W. M. JAEKLE,

BERNARD BLUM, *Vice-Chairman;*
MARO JOHNSON,
S. A. JORDAN,
R. B. KITTREDGE,
A. E. KORSELL,
E. R. LEWIS,
G. P. PALMER,
W. C. PINSCHMIDT,
L. J. RIEGLER,
E. H. ROTH,
H. M. SHEPARD,
B. J. SIMMONS,
G. L. SITTON,
F. J. STIMSON,
M. D. THOMPSON,
W. J. TOWNE,
A. H. UTTER,
V. R. WALLING,
C. E. WEAVER,
LEROY WYANT,

Committee.

To the American Railway Engineering Association:

Your Committee on Grade Crossings submits the following report:

(1) Revision of Manual (Appendix A).

(2) Comparative merits of various types of grade crossing protection, collaborating with Committee X—Signals and Interlocking, the Safety Section, A.R A., and the Highway Research Board (Appendix B).

(3) Economic aspects of grade crossing protection in lieu of grade separation (Appendix C).

(4) Methods and forms for classifying highway crossings of railways and forms for recording and reporting highway and railway traffic over highway grade crossings, collaborating with Committee XI—Records and Accounts (Appendix D).

(5) Methods for developing and evaluating the relative benefits to the public and railways from grade crossing protection or elimination (Appendix E).

(6) Provision which should be included in uniform statutes governing highway grade crossing protection or elimination (Appendix F).

(7) Specifications for location, height and illumination of signs protecting grade crossings, collaborating with Committee X—Signals and Interlocking (Appendix G).

(8) Classification and forms for recording and reporting highway grade crossing accidents with a view to determining the relative extent of contributory causes and merits of protective devices, collaborating with Committees X—Signals and Interlocking, XI—Records and Accounts, the Safety Section, A.R.A., and the Association of Railway Claim Agents (Appendix H).

Bulletin 329, September, 1930.

Action Recommended

(1) That the plans for highway crossing signs and signals, Fig. 1 to 13, inclusive, with accompanying directions, be approved and printed in the Manual in lieu of the directions and Fig. 3 to 8, inclusive, appearing on pages 660 to 666, inclusive, of the 1929 Manual (Appendix A).

(2) That the report be received as information (Appendix B).

(3) That the report be received as information (Appendix C).

(4) That the report be received as information (Appendix D).

(5) That the report be received as information and the conclusion be approved by the Association (Appendix E).

(6) That the conclusions be approved by the Association and that the report be submitted to the A.R.A. Joint Committee on Grade Crossing Protection for further action by the American Railway Association (Appendix F).

(7) That the report be received as information (Appendix G).

(8) That the form be approved and printed in the Manual (Appendix H).

Respectfully submitted,

THE COMMITTEE ON GRADE CROSSINGS,

FRANK RINGER, *Chairman.*

Appendix A

(1) REVISION OF MANUAL

Frank Ringer, Chairman, Sub-Committee; H. E. Barlow, Bernard Blum, J. G. Brennan, H. E. Brink, M. V. Holmes, A. E. Korsell.

The A.R.A. Joint Committee on Grade Crossing Protection, on which the Construction and Maintenance Section is represented by five members of Committee IX, took action on May 14, 1930, recommending the continued use of the present standard automatic flashing light and wigwag crossing signals, with the following changes and additions:

Lights on every signal shall shine in both directions along the highway.

Circuits shall be arranged so that crossing signals will operate until rear end of train reaches crossing, and then cease.

Reflector Type

Each crossing signal shall be equipped with a square sign with black background and white reflecting buttons, displaying the words "Stop on Red Signal" toward highway traffic approaching the near side of the crossing.

Or, when conditions warrant—

Light Type

Each crossing signal shall be equipped with an illuminated sign displaying the word "Stop" in red letters toward highway traffic approaching the near side of the crossing, only while the signal lights are flashing or wigwag swinging.

Bell should be used on crossing signals only when required by public authority or local conditions. Bell should be arranged so as to ring while signal lights are flashing or wigwag swinging.

The American Railway Association at Special Session held at Chicago on May 15, 1930, adopted a resolution as follows: "Resolved that the recommendations relating to signs and signal devices be recommended as standard practice."

It was understood by the Joint Committee that the representatives of the A.R.E.A. and Signal Section would co-operate in preparing revised plans incorporating these recommendations and would submit them for the approval of the A.R.E.A. and Signal Section with a view to their adoption by the A.R.A. as standard practice.

The Committee and representatives of A.R.E.A. Committee X and of Committee XII of the Signal Section have prepared revised plans as shown in Fig. 1 to 13, inclusive, with accompanying directions.

Fig. 1, Advance Warning Signs, is identical with Fig. 6, page 664, 1929 Manual, with addition of directions.

Fig. 2 is the Crossbuck Sign, identical with Fig. 3, page 661, 1929 Manual. No change in this plan is recommended.

Fig. 3 to 6, inclusive, are for wigwag signal, Fig. 7 to 10, inclusive, for flashing light. Fig. 3, 4, 7 and 8 are designed for locations at side of highway, and Fig. 5, 6, 9 and 10 for locations in center of highway. The sign showing number of tracks has been added, as has the provision for

bell when required. The alternate reflector and light type stop signs are shown for each location. In addition to recommendations quoted above, the Joint Committee, at meeting May 14, 1930, recommended that each flashing light unit be equipped with background, and that the minimum vertical clearance of the flashing light units or wigwag disc be seven feet above the surface of the roadway, which features are incorporated in the plans. Otherwise the signals are similar to present standards, Fig. 4, 5 and 7, pages 662, 663 and 665, 1929 Manual.

The plan for center of road installation, Fig. 13, is a revision of Fig. 8, page 666, 1929 Manual, to show provision for widening paving as recommended by the National Safety Conference.

ADVANCE WARNING SIGN

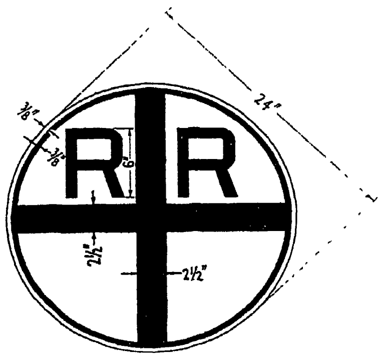


Fig. 1

1. Letters and marking to be painted black on lemon yellow background.

2. Height of Sign: Under ordinary conditions the center of the sign should be placed approximately three and one-half (3½) feet above the crown of the pavement, or traveled way. On ascending or descending grades, this height may be varied so that the rays from headlights may properly illuminate the sign. On city and village streets where the sign is used and where street lights furnish adequate illumination, signs should be placed with the lower edge not less than seven (7) feet above the gutter grade in order to clear parked cars.

3. Lateral Distance: Signs should be erected so that the center is not less than five (5) nor more than seven (7) feet from edge of surfacing on improved roads, except that where a raised curb exists they may be set as close as three (3) feet to the edge of the curb. On unimproved roads, including graded earth, and on narrow roads which may or may not be improved, it is difficult to establish a rule and the general principles of keeping them conspicuous at right angles to traffic, and sufficiently removed from the traveled way to be reasonably safe from damage, should be observed.

HIGHWAY CROSSING SIGN

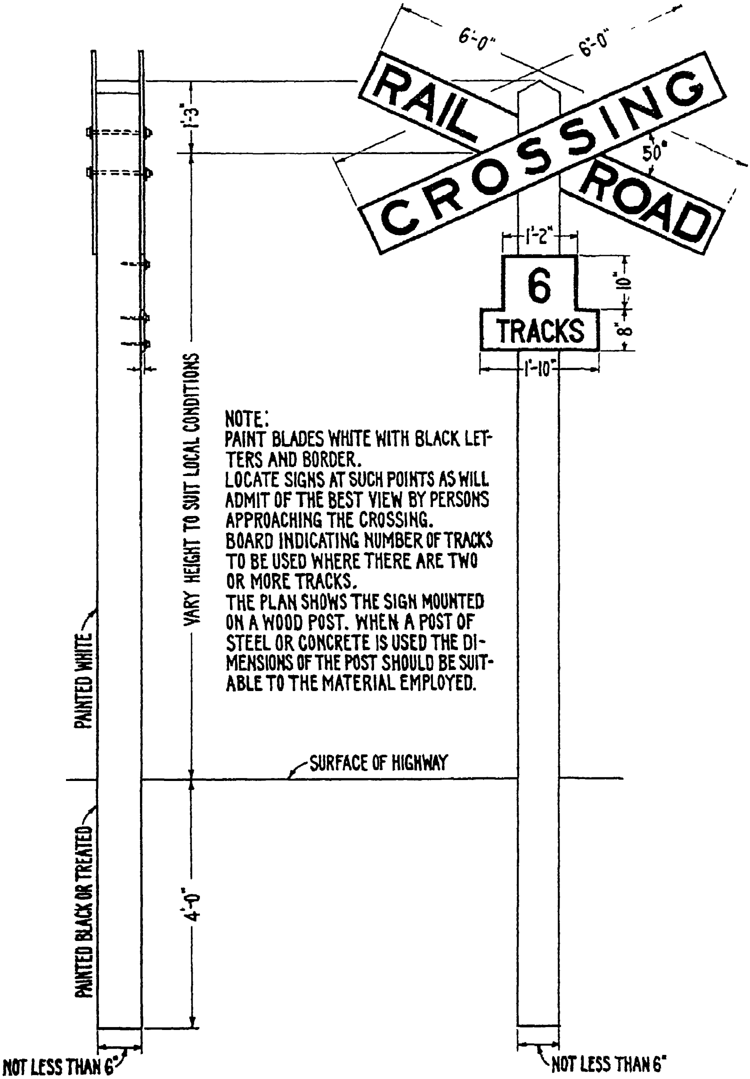
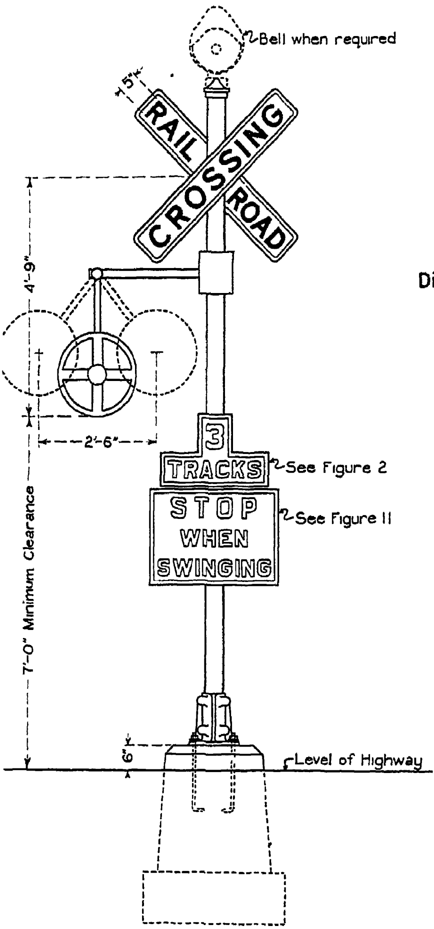


FIG. 2



Directions:-

1 Signal light shall shine in both directions along the highway

2 Reflector sign shall display the words "STOP WHEN SWINGING" in white letters with white reflector lenses on black background toward highway traffic approaching the near side of the crossing

3. Details not shown shall conform to A.R.A. *Signal Section recommended* practice

4. Cross-buck shall be painted white with black letters on both sides

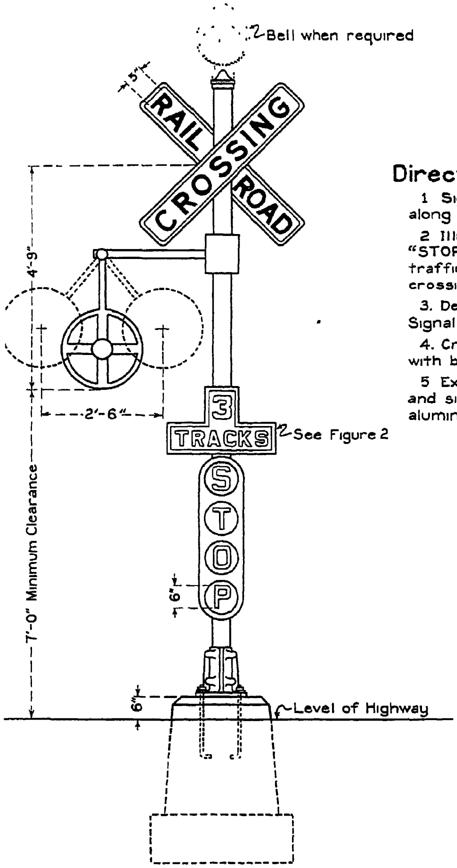
5 Except as otherwise specified, mast and signal shall be painted with white or aluminum paint.

HIGHWAY CROSSING SIGNAL

WIGWAG TYPE

FOR LOCATION AT SIDE OF HIGHWAY

FIGURE-3



Directions:-

1 Signal light shall shine in both directions along the highway

2 Illuminated sign shall display the word "STOP" in red letters toward highway traffic approaching the near side of the crossing only while wigwag is swinging

3. Details not shown shall conform to A R A. Signal Section recommended practice

4. Cross-buck shall be painted white with black letters on both sides.

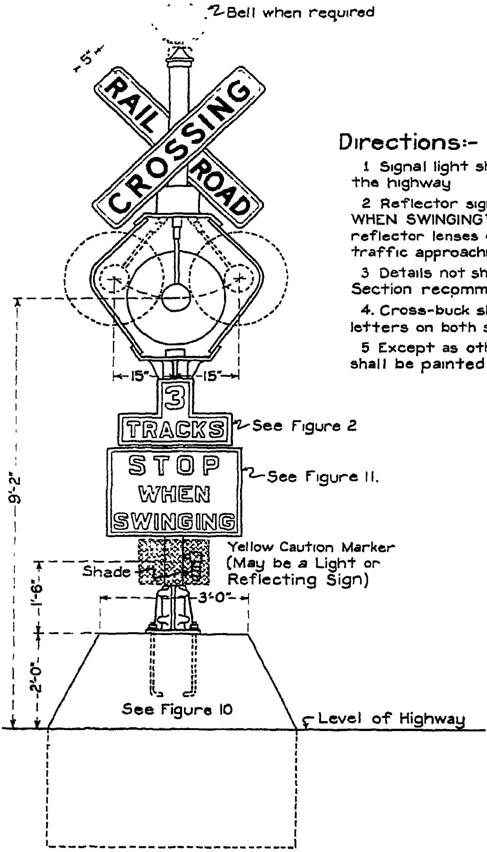
5 Except as otherwise specified, mast and signal shall be painted with white or aluminum paint.

HIGHWAY CROSSING SIGNAL

WIGWAG TYPE

FOR LOCATION AT SIDE OF HIGHWAY

FIGURE-4



Directions:-

1 Signal light shall shine in both directions along the highway

2 Reflector sign shall display the words "STOP WHEN SWINGING" in white letters with white reflector lenses on black background toward highway traffic approaching the near side of the crossing.

3 Details not shown shall conform to A.R.A Signal Section recommended practice.

4. Cross-buck shall be painted white with black letters on both sides

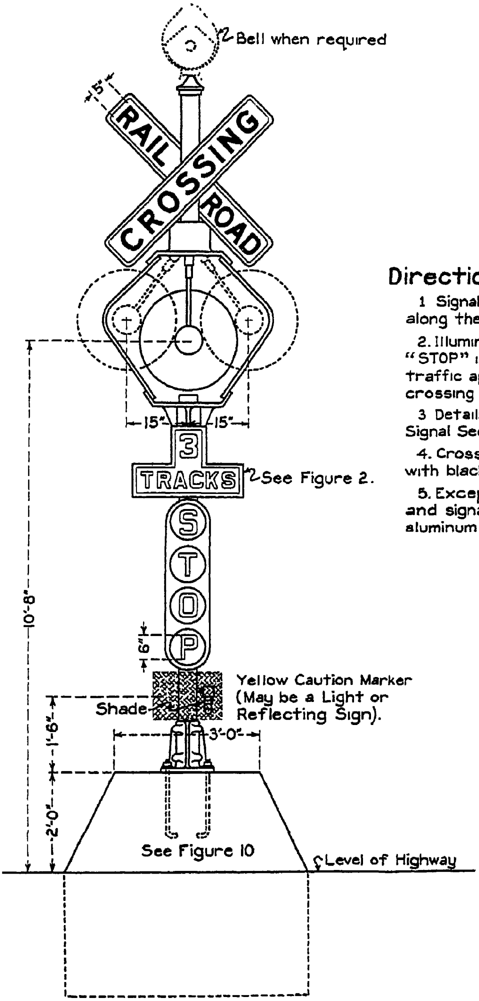
5 Except as otherwise specified, mast and signal shall be painted with white or aluminum paint.

HIGHWAY CROSSING SIGNAL

WIGWAG TYPE

FOR LOCATION IN CENTER OF HIGHWAY

FIGURE -5



Directions:-

1 Signal light shall shine in both directions along the highway.

2. Illuminated sign shall display the word "STOP" in red letters toward highway traffic approaching the near side of the crossing only while wigwag is swinging.

3 Details not shown shall conform to A.R.A. Signal Section recommended practice.

4. Cross-buck shall be painted white with black letters on both sides.

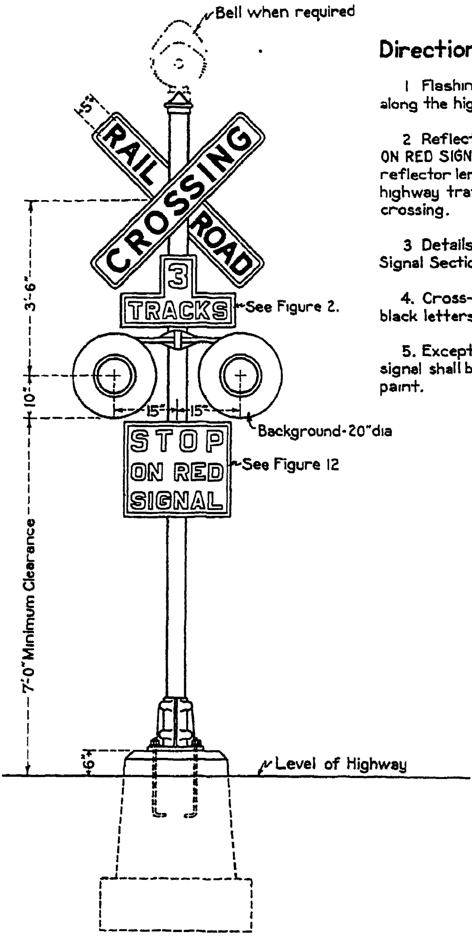
5. Except as otherwise specified, mast and signal shall be painted with white or aluminum paint.

HIGHWAY CROSSING SIGNAL

WIGWAG TYPE

FOR LOCATION IN CENTER OF HIGHWAY

FIGURE-6



Directions:-

1 Flashing lights shall shine in both directions along the highway.

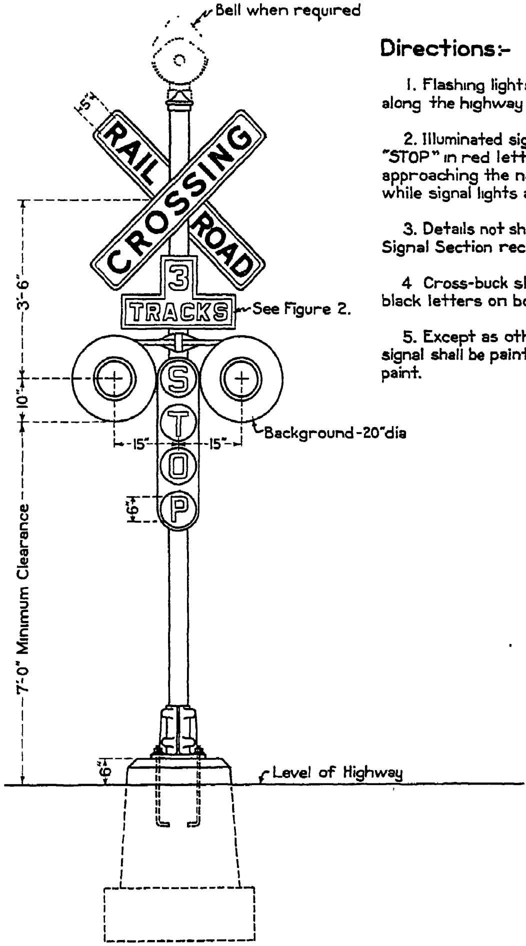
2 Reflector sign shall display the words "STOP ON RED SIGNAL" in white letters with white reflector lenses on black background toward highway traffic approaching the near side of the crossing.

3 Details not shown shall conform to A R A Signal Section recommended practice

4. Cross-buck shall be painted white with black letters on both sides

5. Except as otherwise specified, mast and signal shall be painted with white or aluminum paint.

HIGHWAY CROSSING SIGNAL
FLASHING LIGHT TYPE
FOR LOCATION AT SIDE OF HIGHWAY
FIGURE - 7



Directions:-

1. Flashing lights shall shine in both directions along the highway

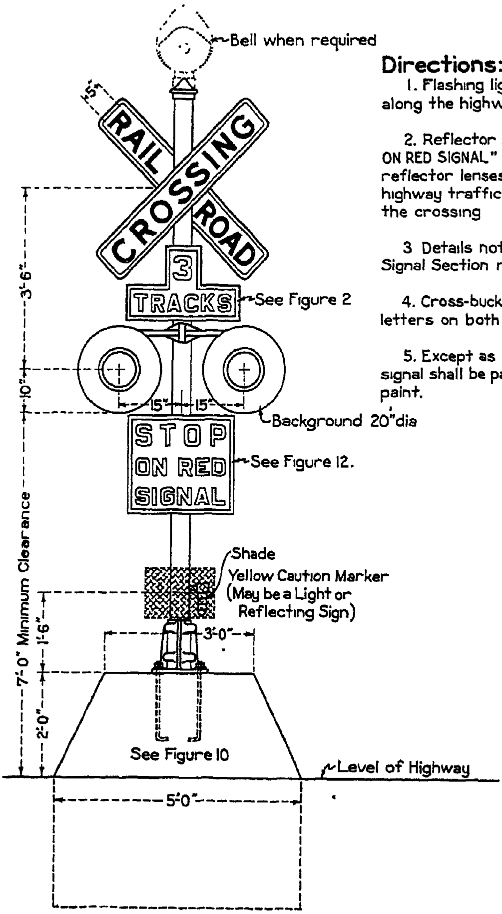
2. Illuminated sign shall display the word "STOP" in red letters toward highway traffic approaching the near side of the crossing only while signal lights are flashing.

3. Details not shown shall conform to A.R.A Signal Section recommended practice.

4 Cross-buck shall be painted white with black letters on both sides.

5. Except as otherwise specified, mast and signal shall be painted with white or aluminum paint.

HIGHWAY CROSSING SIGNAL
FLASHING LIGHT TYPE
FOR LOCATION AT SIDE OF HIGHWAY
FIGURE-8



Directions:-

1. Flashing lights shall shine in both directions along the highway

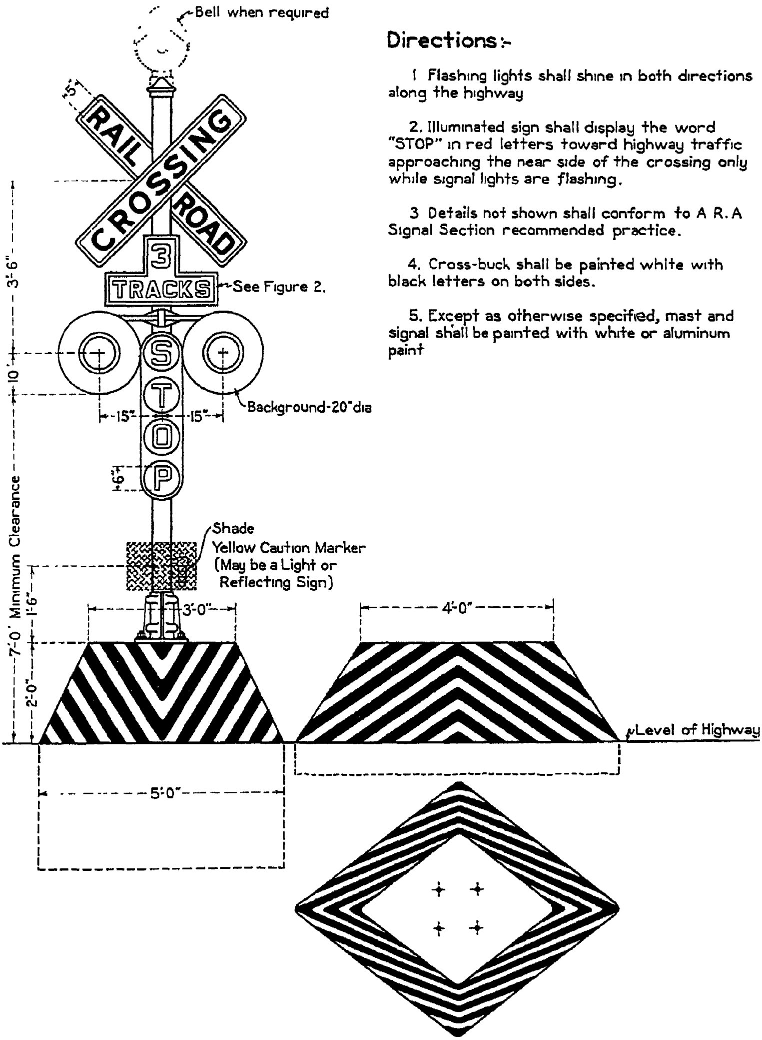
2. Reflector sign shall display the words "STOP ON RED SIGNAL" in white letters with white reflector lenses on black background toward highway traffic approaching the near side of the crossing

3 Details not shown shall conform to A R A Signal Section recommended practice.

4. Cross-buck shall be painted white with black letters on both sides

5. Except as otherwise specified, mast and signal shall be painted with white or aluminum paint.

HIGHWAY CROSSING SIGNAL
FLASHING LIGHT TYPE
FOR LOCATION IN CENTER OF HIGHWAY
FIGURE-9



Directions:-

1 Flashing lights shall shine in both directions along the highway

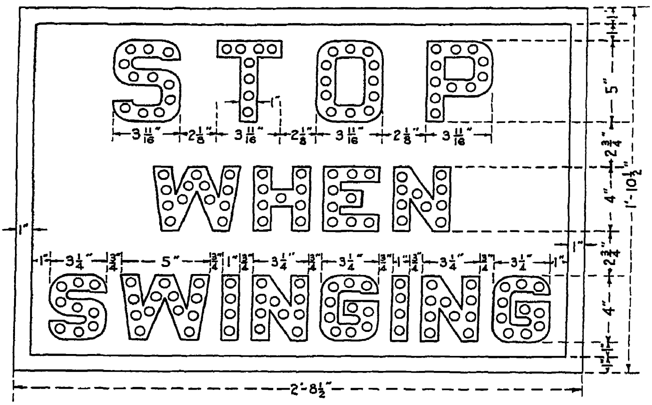
2. Illuminated sign shall display the word "STOP" in red letters toward highway traffic approaching the near side of the crossing only while signal lights are flashing.

3 Details not shown shall conform to A R.A Signal Section recommended practice.

4. Cross-buck shall be painted white with black letters on both sides.

5. Except as otherwise specified, mast and signal shall be painted with white or aluminum paint

HIGHWAY CROSSING SIGNAL
FLASHING LIGHT TYPE
FOR LOCATION IN CENTER OF HIGHWAY
FIGURE–10



Directions:-

White letters on black background with white border - all dull finish.

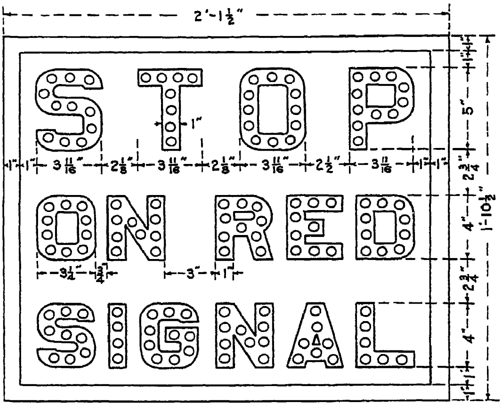
Reflector lenses - Crystal (colorless) $\frac{11}{16}$" diameter.

REFLECTOR LENS SIGN

FOR WIGWAG TYPE

HIGHWAY CROSSING SIGNAL

FIGURE - 11



Directions:-

White letters on black background with white border-all dull finish.

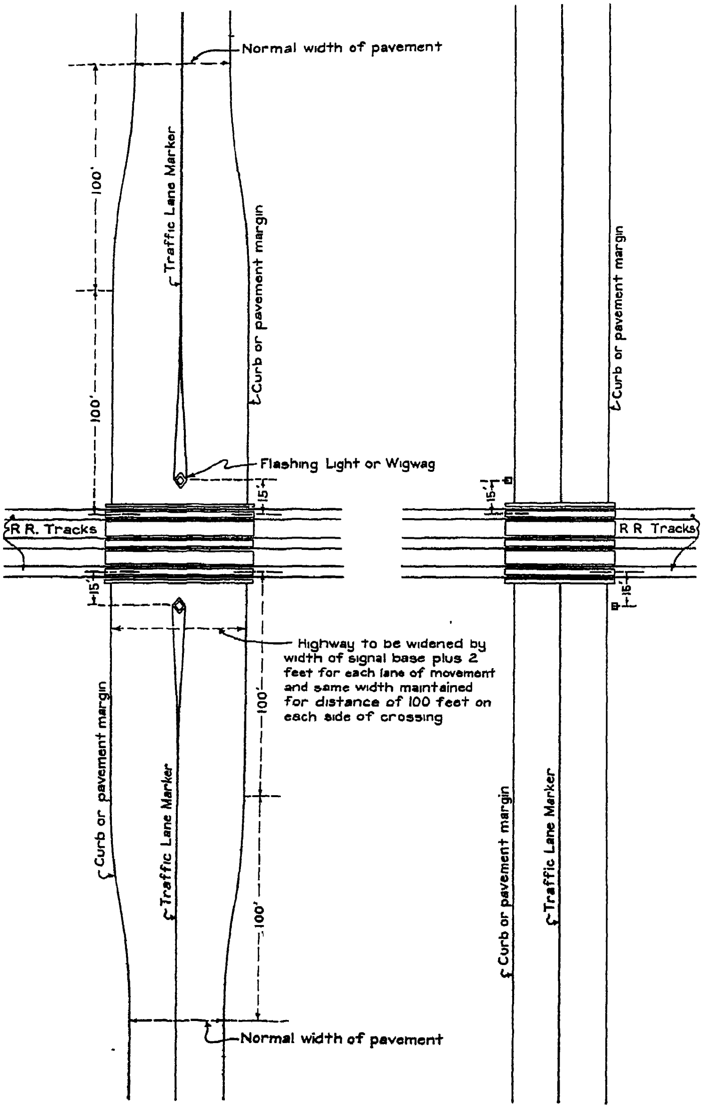
Reflector lenses-Crystal (colorless) $\frac{11}{16}$" diameter.

REFLECTOR LENS SIGN

FOR FLASHING LIGHT TYPE

HIGHWAY CROSSING SIGNAL

FIGURE-12



CENTER OF ROAD INSTALLATION SIDE OF ROAD INSTALLATION

FIGURE – 13

HIGHWAY CROSSING SIGNS AND SIGNALS

(1) Advance warning sign, Fig. 1, to be placed as required by local conditions, not less than 200 feet (in cities not less than 100 feet), nor more than 450 feet from crossing.

(2) Highway crossing sign, Fig. 2, to be used as required where manual or automatic protection is not provided.

(3) At crossings on heavily traveled highways where conditions justify, either of the following standard visible warning signals should be installed:

(a) Wigwag type—Fig. 3, 4, 5, 6.
(b) Flashing light type—Fig. 7, 8, 9, 10

(4) At crossings where wigwag or flashing light signals are used, one should be placed on each side of the track. In cities and towns where the street is of sufficient width, signals may be located in the center of the street—Fig. 5, 6, 9, 10, 13.

(5) Circuits for automatic operation of wigwag or flashing light signals shall be arranged so that crossing signals will operate until rear of train reaches or clears crossing.

(6) Bell should only be used on crossing signals when required by local conditions. Bell should be arranged so as to ring while signal lights are flashing or wigwag swinging.

Recommendation

The Committee recommends that the plans for Highway Crossing Signs and Signals, Fig. 1 to 13, inclusive, with accompanying directions, be adopted by the Association as recommended practice, to be substituted for directions, and Fig. 3 to 8, inclusive, appearing on pages 660 to 666, inclusive, in the 1929 Manual.

Appendix B

(2) COMPARATIVE MERITS OF VARIOUS TYPES OF GRADE CROSSING PROTECTION, COLLABORATING WITH COMMITTEE X—SIGNALS AND INTERLOCKING, THE SAFETY SECTION, A.R.A., AND THE HIGHWAY RESEARCH BOARD

J. G. Brennan, Chairman, Sub-Committee; Bernard Blum, H. D. Blake, G. N. Edmondson, H. L. Engelhardt, P. M. Gault, Maro Johnson, W. C. Pinschmidt, L. J. Riegler, H. M. Shepard, Leroy Wyant.

Following is a list of the various types of grade crossing protection given consideration by the Committee during the past year. They are briefly described from the claims of the manufacturers.

(1) **Safe-T-Bar Automatic Highway Grade Crossing Barrier of the Highway Guardian.**—This is a gates-lights type of protection. It consists of a yielding barrier arm which can be controlled manually, semi-automatic, full automatic, or a combination of the three methods.

(2) **The Lightning Flash Crossing Signal.**—This is an automatic light which flashes a 5-ft. zigzag red light about 50 times per minute as the train approaches.

(3) **Foard Safety Device.**—This consists of lights, gates and train control. This is a device which automatically stops trains if obstruction is on the crossing after the gates have been lowered.

(4) **Yielding Barrier Gates.**—This is an automatic yielding barrier gate which rises and lowers vertically on a horizontal plane.

(5) **Max Friedland Method.**—This consists of gates, lights, bells and train control. An automatic train control device depending on the position of the crossing gates, which when once lowered cannot be raised until the train is clear of the crossing

(6) **The Standard Automatic Signal Gate.**—This consists of gates, lights and bells. It is an automatic gate controlled by the approaching train The lights flash and the bells ring a suitable interval before the gates are lowered.

(7) **O. L. Suenderhauf Method.**—This consists of gates and lights. The gate is an automatic rigid gate which rises and lowers vertically on a horizontal plane.

(8) **The American Automatic Gate.**—This consists of gates and lights. A rigid automatic gate which rises and lowers vertically on a horizontal plane.

(9) **The Hubbard Smoke Signal.**—This is known also as the "Auto Highway Signal." It consists of a pipe post set in a concrete foundation. The post supports the operating mechanism consisting of a magazine to hold a supply of smoke flares, one of which is released and ignited by an electric spark, when approaching trains enter the highway crossing area. The smoke is thrown across the highway.

(10) **Miner Super-Safety Gate and Signal System.**—This operates automatically with the approach of a train. Warning is given through the medium of a siren which is immediately followed by a visible signal to highway traffic, which in turn is prevented from entering the danger zone by the lowering of a gate. Signals are also operated for the benefit of train crews by semaphore display of a red signal until the approach of the train sets in motion the foregoing operation, which in turn opens the track by a signal for through movement of the train.

(11) **"Balagrav" Gate.**—This device consists of gates, lights and siren. An automatic gate illuminated the full length by Neon gas light or electric bulbs. A shrill siren sounds as the train approaches.

(12) **Neon Signal Devices, Inc.**—These are lighting signals by means of Neon tubing.

(13) **Automatic Crossing Gate.**—This is a counterbalanced gate with very low power consumption. If the arm should come down on a vehicle the power to that arm is alternately reversed and applied until the obstruction is removed. If the arm is held down the power to that arm is shut off but restored automatically upon release. Impact cables parallel the arm, and when the arm in the barrier position if struck takes the barrier impact. The arms rotate horizontally if struck. The arms carry Ruby Flashing Lights, and a beam light which illuminates the arm while in operation.

(14) **Magnetic Wigwag.**—This is a swinging banner with bell and red light controlled by the approaching train.

(15) **Locomotive Bell Device.**—This is an audible warning controlled by the approaching train.

(16) **National Safety Appliance.**—This is a Two-Train Indicator, which gives visible and audible warning of other train or trains approaching the crossing after the first train has operated crossing protection. This is an auxiliary device used in conjunction with flashlight or wigwag.

(17) **Rotating Type Stop Signal, made by the Railroad Supply Company and the Griswold Safety Signal Company.**—This is a flashing type light signal in conjunction with a standard stop sign disc which displays the stop sign against highway traffic on the approach of a train.

(18) **Hoeschen Crossing Signal.**—The Hoeschen Crossing Signal utilizes the deflection of rail to start and stop signal. It is equipped with locomotive bell and swinging signal blades.

(19) **Kahler Automatic Gate.**—This is an automatic gate controlled by the approaching train. The gate is held clear by compressed air. The gate moves by gravity to stop position.

(20) **Highway Traffic Signals.**—Highway Traffic Signals are used in some municipalities and are controlled by the approach of trains. The Boston & Albany Railroad has installed some of these signals near Mittineague Station on that railroad. The signals are operated by a railroad employee who is a uniformed policeman in the town as well.

Recommendation

The Committee recommends that the report be received as information.

Appendix C

(3) ECONOMIC ASPECTS OF GRADE CROSSING PROTECTION IN LIEU OF GRADE SEPARATION

H. E. Barlow, Chairman, Sub-Committee; F. D. Batchellor, H. D. Blake, Ray Henry, W. M. Jaekle, A. E. Korsell, G. P. Palmer, E. H. Roth, W. J. Towne, A. H. Utter.

The Committee has received and compiled information as to cost of grade crossings and crossing protection based on replies to questionnaire received after last year's report was issued. It is desirable to secure additional data with a view to developing representative costs.

Recommendation

The Committee recommends this report be received as information.

Appendix D

(4) METHODS AND FORMS FOR CLASSIFYING HIGHWAY CROSSINGS OF RAILWAYS AND FORMS FOR RECORDING AND REPORTING HIGHWAY AND RAILWAY TRAFFIC OVER HIGHWAY GRADE CROSSINGS, COLLABORATING WITH COMMITTEE XI—RECORDS AND ACCOUNTS

H. E. Brink, Chairman, Sub-Committee; H D. Blake, J. E. Breen, S. N. Crowe, L. B. Curtiss, M. V. Holmes, S. A. Jordan, E. R. Lewis, H. M. Shepard, A. H. Utter, V. R. Walling.

(a)

.. .. .Railroad

.. . .Division

OUTLINE FOR CLASSIFICATION OF HIGHWAY GRADE CROSSINGS

Information should be obtained by field inspection and from records. It should be compiled on ground in tabular form which should be filled out, dated and certified as correct by the Engineer making the inspection. Information shall be compiled for all grade crossings of highways, local roads and streets by operating divisions serially in the order of mileposts.

1. Milepost and tenths.
2. Class of highway, local road or street as follows:

Abbreviation	*Class*
F.A.P.	Federal Aid—Primary
F.A.S.	Federal Aid—Secondary
O.R.	Other Roads—State or County
L.R.	Local Road
Street	Street within limits of incorporated city, not maintained by state highway commission.

3. U.S. number of highway or street.
4. State number of highway or street.
5. Name of highway, road or street.
6. Number of street car tracks.
7. Number of main tracks crossed.
8. Number of side and or spur tracks crossed.
9. Tracks of other Railroads.
10. Approximate angle of crossing.
11. Character of highway alinement for 1000 feet each side of crossing.
12. Kind of surface of highway, road or street, approaching the crossing:
    (a) Concrete or brick.
    (b) Bituminous macadam or bituminous concrete.
    (c) Waterbound macadam, gravel, etc.
    (d) Earth.

13. Width of surface of highway, road or street, within 500 feet each side of crossing.
14. Kind of surface of crossing:
    (a) Metal or metal and concrete.
    (b) Stone, concrete or brick.
    (c) Bituminous.
    (d) Crushed stone, gravel or slag.
    (e) Plank (wood).
    (f) Plank (concrete, bituminous, etc.).
    (g) Patented materials.
    (h) Earth.
15. Length of surface of crossing, measured along center line of railroad.
16. Visibility:
    (a) "Good"—Train or locomotive visible for at least one thousand feet each way along track from approaching vehicle within a distance of two hundred feet either way from crossing.
    (b) "Fair"—Train or locomotive visible for at least one thousand feet each way along track from approaching vehicle within a distance of one hundred feet either way from crossing.
    (c) "Restricted"—Other conditions.
17. Approach highway grades (state whether ascending or descending).
    (a) "Easy"—Approximately level for 10 to 20 feet and thence not over 5 per cent.
    (b) "Medium"—Approximately level for 10 to 20 feet and thence 5 per cent to 10 per cent.
    (c) "Steep"—Approximately level for 10 to 20 feet and thence over 10 per cent.
18. Maximum speed of passenger trains (m p.h.).
19. Maximum speed of freight trains (m.p.h.).
20. Number of passenger trains per day (24 hours) (average for one month).
21. Number of freight trains per day (24 hours) (average for one month).
22. Number of switching movements per day (24 hours) (average for one month).
23. Highway traffic per day (24 hours). Show number from representative traffic count.
24. Kind of protection, if any, other than standard highway crossing signs as follows:
    (a) Gates—With or without other protection.
    (b) Watchmen—Alone or with protection, other than gates.
    (c) Automatic gates.
    (d) Automatic signals—Visible—With or without audible feature.
    (e) Automatic signals—Audible only.
25. Is elimination of grade crossing feasible:
    (a) By relocation of highway—considering topography, property values and adjacent improvements at reasonable cost.
    (b) By separation of grade—considering topography, drainage, adjacent improvements and possible change in grade of highway or railroad at reasonable cost.
    (c) By vacation or closing and diversion of traffic to other crossing or crossings, considering the character and density of highway traffic and extent of inconvenience thereto.
26. What percentage of highway traffic can be diverted by relocation.
27. Total accidents at crossing for a period of past five years.

SUMMARY

Summarize for each class of highway to show number of crossings by operating divisions, states, and total, classified as follows:

(a) Number of tracks crossed:
- (1) Crossing of single main track only.
- (2) Crossing of double main track only.
- (3) Crossing of more than two main tracks only.
- (4) Crossing of single main track and one or more other tracks.
- (5) Crossing of double main track and one or more other tracks.
- (6) Crossing of more than two main tracks and one or more other tracks.
- (7) Crossing of tracks of other railroads.

(b) Kind of highway surface:
- (1) Concrete or brick.
- (2) Bituminous macadam or concrete
- (3) Waterbound macadam, gravel, etc.
- (4) Earth.

(c) Kind of surface of crossing:
- (1) Metal or metal and concrete.
- (2) Stone, concrete or brick.
- (3) Bituminous.
- (4) Crushed stone, gravel or slag.
- (5) Plank (wood).
- (6) Plank (concrete, bituminous, etc.).
- (7) Patented materials.
- (8) Earth.

(d) Visibility:
- (1) Good.
- (2) Fair.
- (3) Restricted.

(e) Approach highway grade:
- (1) Easy.
- (2) Medium.
- (3) Steep.

(f) Maximum train speed:
- (1) Slow, up to 20 m.p.h.
- (2) Medium, 20—40 m.p.h.
- (3) Fast, over 40 m.p.h.

(g) Kind of protection:
- (1) Gates.
- (2) Watchmen.
- (3) Automatic gates.
- (4) Automatic signals—visible.
- (5) Automatic signals—audible only.
- (6) Crossing signs only.

(h) Elimination or grade separation:
- (1) Elimination of crossing by relocation of highway, feasible.
- (2) Grade separation, feasible.
- (3) Closing of crossing and diversion of highway traffic to another crossing or crossings, feasible.
- (4) Reduction of highway traffic by relocation of highway.
- (5) Other crossings.

(i) Totals.

Recommendation

It is recommended that this report be received as information.

(b)

.. . .Railroad

... .Division

RECORD OF RAILROAD AND HIGHWAY TRAFFIC OVER HIGHWAY GRADE CROSSINGS

Information should be obtained by field inspection and from records. It should be compiled on ground in tabular form which should be filled out, dated and certified as correct by the Engineer making the inspection. Information shall be compiled for all grade crossings of highways, local roads and streets by operating divisions serially in the order of mileposts.

1. Milepost and tenths.
2. Name of highway, road or street.
3. Location—nearest railroad station.
4. Number of trains per day, divided between day time and night time.
   (a) Passenger ....Day......Night......Total......
   (b) Freight ....Day......Night......Total......
   (c) Switching movements .....Day......Night......Total......
   (d) Total .... Day......Night......Total......
   Note time of occupation by trains at the crossing.
5. Maximum speed of trains m.p.h.
   (a) Passenger.
   (b) Freight.
6. When do peak hours occur for railroad traffic, and what is its magnitude?
   (a) Passenger . ...Hours...Number...Hour...Number...
   (b) Freight ....Hour ...Number...Hour...Number...
   (c) Switching movements.Hour ...Number...Hour...Number...
7. Highway traffic per day, divided between day time (6:00 a.m. to 6:00 p.m.) and night time (6:00 p.m. to 6.00 a.m.) from representative traffic count when available.
   (a) Pleasure automobiles ......Day......Night......Total......
   (b) Commercial automobiles ...Day......Night......Total......
   (c) Busses ....Day... ..Night......Total......
   (d) Horse drawn vehicles......Day......Night......Total......
   (e) Motorcycles ....Day......Night......Total. ....
   (f) Pedestrians .... Day ....Night .....Total......
   (g) Miscellaneous (farm machinery, steam shovels, etc.).Day......Night......Total......
   (h) Totals ....Day .....Night......Total......
8. When do peak hours occur for highway traffic, and what is its magnitude?
   (a) Pleasure automobiles ....Hour..Number..Hour..Number..
   (b) Commercial automobiles ..Hour..Number..Hour..Number..
   (c) Busses ....Hour..Number..Hour..Number..
   (d) Horse drawn vehicles.....Hour..Number..Hour..Number..
   (e) Motorcycles ....Hour..Number..Hour..Number..
   (f) Pedestrians ....Hour..Number..Hour..Number..
   (g) Miscellaneous (farm machinery, steam shovels, etc.).Hour..Number..Hour..Number..

Recommendation

It is recommended that this form be received as information.

Appendix E

(5) METHOD FOR DEVELOPING AND EVALUATING RELATIVE BENEFITS TO THE PUBLIC AND RAILWAYS FROM GRADE CROSSING PROTECTION OR ELIMINATION

A. E. Korsell, Chairman, Sub-Committee; R. W. Barnes, H. D. Blake, H. E. Brink, R. B. Kittredge, Ray Henry, G. L. Sitton, F J. Stimson, M. D. Thompson, C. E. Weaver.

Relative benefits and divisions of cost of grade separation projects are generally determined by orders of commissions or agreements on basis of judgment in view of the circumstances in the individual case, or by arbitrary percentages which are in some states fixed by law. The Committee, after further consideration, has been unable to develop and formulate a method for evaluating the relative benefits from grade crossing protection or elimination other than the principles previously formulated and printed in the Manual. So far as the Committee can learn no other method or formula has been developed or is in use.

The cost of a grade crossing elimination or separation project has been defined as the difference between the appraised cost of improving the highway with grades separated and the cost of such improvement with crossing at grade.

A method has been published for determining the relative priority of highway grade crossings, for the purpose of programming grade crossing eliminations, on the basis of appraised cost or value of delays to highway traffic. It appears that as a general rule the risk of accident or hazard of operation of the highway and railway will vary approximately, other things being equal, with the volume of highway and railway traffic or approximately with the delays to highway traffic. Another method has been published for determining such priority on the basis of relative hazards of operation. Such methods have the disadvantage that they depend partly upon arbitrary or assumed factors. None of these methods go directly to the question of evaluating relative benefits for the purpose of division of costs.

The Third National Conference on Street and Highway Safety, held at Washington, D. C., May 27-29, 1930, adopted the following:

> "To facilitate prompt provision of more adequate protection of railway crossings there should be a fair division of costs of such protection as well as of elimination of obstruction to view and other hazards, and of maintenance of roadway between and adjacent to the tracks, following the principles which have been recognized in apportionment of costs of grade separations."

The increasing need for grade crossing protection is resulting primarily from the largely increasing volume of highway traffic and it is only reasonable and fair that the public should participate in the total costs of such protection, including installation, upkeep and operation.

Conclusion

It is the conclusion of the Committee that the principles as already adopted by the Association and as printed in the Manual embody the proper method for developing and evaluating relative benefits to the public and railways from grade crossing protection or elimination.

Appendix F

(6) PROVISION WHICH SHOULD BE INCLUDED IN UNIFORM STATUTES GOVERNING HIGHWAY GRADE CROSSING PROTECTION OR ELIMINATION

Bernard Blum, Chairman, Sub-Committee; H. E. Barlow, R. W. Barnes, C. W. Charleson, A. F. Dorley, F. S. Hales, A. G. Holt, L. J. Riegler, B. J. Simmons, W. J. Towne.

Without legislative indication to the contrary, it has been contended that a railway company should carry roads over its right-of-way at a separated grade when public safety demands. In recent years, the phenomenal development of motor traffic has so revolutionized conditions that the uncompensated duty of railways at common law must now be supplanted by fair and equitable apportionment through legislative enactment.

A number of the states have had the wisdom to provide statutes for this important problem. This recommendation has been adopted by each conference that has considered the subject. In 1926 the Hoover conference so voted unanimously.

Careful consideration will show that in the several Railroad Commissions or corresponding regulatory state bodies there should be vested the authority not only to apportion the cost of grade separations but also to determine the necessity for new grade crossings and protection of same. It is fair to assume that a large proportion of the travel on the streets and highways is no longer local in extent, but state wide and even interstate. While the local governing bodies are still charged with the policing of the highways in cities and towns even that has given way, in a large measure, to state highway patrols.

The railroads have created no new or additional hazards at grade crossings. In general, growth in traffic has been met, not by increase in train miles, but by larger cars and longer train units. The increase in hazard is due to the enormous development in automobile traffic on the highways, including faster speed. It has frequently been argued that grade separations are economically justified in that the avoidance of stopping numerous automobiles with the savings in gasoline, tire wear, brake bands, etc., together with saving in time would bring in a good return on the cost. This is a further reason why the public, which is benefited by such savings, should pay for such benefits.

It appears almost axiomatic that the city, highway department, or other public body which requests the separation or installation of protective devices, being the plaintiff, is not in position to determine impartially a fair division of cost. The railroad commission, more than any other, is a disinterested public body to be given quasi-judicial authority to hear evidence and best decide what should be done. They have engineering assistance and advice, and are best qualified to pass on the projects most in need of attention.

The position that the entire expense of grade protection or separation should be borne by the railroads cannot be maintained. The burden of cost would ultimately be passed to the shippers and traveling public, neither

of whom might be benefited in the case in question. The communities are as much and generally more interested in the improvement than the railroad. The benefits flow directly to the community. The public is benefited by the expediting of traffic and hence should assume a substantial part of such cost. To leave the power to separate grades to local municipalities permits them to take an undue proportion of the revenue of railroads for themselves and leave little for separations in other portions of the state. A body familiar with the financial problems of the railroads should pass upon such questions.

In the days of horsedrawn vehicles it was not considered that the highways were directly in competition with the railroads. Today a large share of the highway traffic that causes the demand for grade separation is taking away business that formerly went to the railroads, and if those directly benefited do not share in the cost, the remaining users of the railroads will pay for the improvement through an interest charge on the capital investment.

While the apportionment of expense may properly vary under different circumstances, fairness dictates some broad divisions which should be incorporated in uniform statutes governing the matter. Arbitrary divisions, while a step in the right direction, are not always satisfactory. The element of benefits cannot be ignored although frequently an undue apportionment of benefit is charged to the railroads. The benefits that accrue to the political subdivisions of the state as well as to the general public must be recognized.

Conclusions

Statutes governing highway grade crossing protection or separation should include the following provisions. (By "Railroad Commission," as referred to, it is intended to designate the state regulatory body having control over railroads.)

1. The Railroad Commission should have jurisdiction over crossing protection and grade separation projects on all public highways.
2. The apportionment of expense for crossing protection and grade separation should be:
   - (a) For highways forming part of the Federal Aid System, between Federal Aid, the Highway Department and the Railroad.
   - (b) For county highways, between the County, the State and the Railroad.
   - (c) For city streets, between the City, the County, the State and the Railroad.
3. The Railroad Commission should be authorized and required to prescribe uniform warning signs for use at grade crossings.
4. No new grade crossings should be constructed except on order of the Railroad Commission following a hearing.
5. The Railroad Commission should be empowered to designate "Stop" crossings and the statutes should provide for the creation of same and penalties for failure to stop at such designated crossings.

6. No grade separation project and no new overgrade or undergrade crossing should be constructed except with the approval of the Railroad Commission.

7. The Railroad Commission should prescribe the physical characteristics for new crossings with respect to approach grades, width of approaches and planking, etc.

8. State Highway Departments, Counties and Municipalities should be empowered to negotiate grade separation projects or new crossing projects involving under or overhead structures, with Railroad Companies, subject to approval of the Railroad Commission.

Recommendation

The Committe erecommends that the Conclusions be approved by the Association and that the report be submitted to the A.R.A. Joint Committee on Grade Crossing Protection for further action by the American Railway Association.

Appendix G

(7) SPECIFICATIONS FOR LOCATION, HEIGHT AND ILLUMINATION OF SIGNS PROTECTING GRADE CROSSINGS, COLLABORATING WITH COMMITTEE X—SIGNALS AND INTERLOCKING

J. G. Brennan, Chairman, Sub-Committee; Bernard Blum, H. D. Blake, G. N. Edmondson, H. L. Engelhardt, P. M. Gault, Maro Johnson, W. C. Pinschmidt, L. J. Riegler, H. M. Shepard, Leroy Wyant.

Illumination of the advance warning sign should be effected by the use of crystal (colorless) reflector button lenses eleven-sixteenths ($\frac{11}{16}$) inch in diameter set in the letters "RR."

Illumination of the Highway Crossing Sign (Crossbuck Sign) shall be effected by the use of crystal (colorless) reflector button lenses eleven-sixteenths ($\frac{11}{16}$) inch in diameter set in the letters of the words "RAILROAD CROSSING."

Recommendation

It is recommended that this report be received as information.

Appendix H

(8) CLASSIFICATION AND FORMS FOR RECORDING AND REPORTING HIGHWAY GRADE CROSSING ACCIDENTS WITH A VIEW TO DETERMINING THE RELATIVE EXTENT OF CONTRIBUTORY CAUSES AND MERITS OF PROTECTIVE DEVICES, COLLABORATING WITH COMMITTEES X—SIGNALS AND INTERLOCKING, XI—RECORDS AND ACCOUNTS, THE SAFETY SECTION, A.R.A., AND THE ASSOCIATION OF RAILWAY CLAIM AGENTS

M. V. Holmes, Chairman, Sub-Committee; F. D. Batchellor, J. E. Breen, H. L. Engelhardt, P. M. Gault, Maro Johnson, E. R. Lewis, E. H. Roth, Leroy Wyant.

This Sub-Committee has carried forward the work begun in 1929 and as the result of two joint meetings with the Safety Section, A.R.A., and Association of Railway Claim Agents, the accompanying form (Fig. 1 and 2) has been agreed upon as suited to the purposes of the three organizations. Collaboration with Committee XI was carried on by correspondence.

The form proposed is about as brief as it can be made and still collect the information desired. It could be enlarged considerably but this is not recommended as the brevity will contribute a large part to its successful use. Various states now are demanding surveys of existing grade crossings and it appears to be only a question of time until all roads will maintain a file showing physical characteristics of grade crossings. Such a file will assist in the compilation of data on the recommended form.

Recommendation

The Committee recommends the adoption of this form as recommended practice.

Serial No ______ File No ______

______________________________ Railroad

HIGHWAY CROSSING ACCIDENT REPORT

OPERATING DIVISION______________________________

TIME (1) Date________ (2) Time________M (3) Daylight________ (4) Dark________ (5) Weather________

PLACE (6) State________ (7) Nearest Station________________ (8) Distance-direction from station ________ (9) Name of crossing________________ (10) Nearest Mile Post No ________

TRAIN (11) Kind of train____________ (12) Train No________ (13) Engine No ________ ________bound (14) No. of cars________ Movement of train (15) forward________ (16) backward________ (17) pushing cars________ (18) Speed of train________m p h (19) Distance from crossing to place where engine stopped ________feet (20) Was train derailed?________

TRACK Track on which accident occurred (21) main________ (22) siding ________ (23) industrial________ (24) other________ (25) straight________ (26) curved________ (27) level________ (28) upgrade________ (29) down grade________ (30) No of tracks at crossing________ (31) How many intervening tracks did traveler pass? ________

CROSSING (32) State Road________ (33) County________(34) rural________ (35) private________ (36) street________ Angle of driver's approach to crossing with reference to train: (37) right________ (38) acute________ (39) obtuse ________ Highway approach is (40) straight________ (41) curved________ (42) level________ (43) upgrade________ (44) downgrade________ (45) Material of highway approach____________ Condition (46) good________ (47) poor________ (48) Total width of highway roadbed____________ (49) Width of traveled highway ____________ (50) Width of traveled highway over tracks____________ (51) Material of crossing ____________ (52) Condition good________ (53) poor________ (54) Surface of crossing is level________ feet from nearest rail (55) Did highway parallel track within 100 feet of crossing?________ (56) Proximity and importance of adjacent crossings________________________

CROSSING PROTECTION (57) Advance warning signs________ (58) Highway pavement RR markings________ (59) crossing signs________ (60) watchman________ (61) gates________ (62) wig wag________ (63) flasherlight________ (64) bell________ (65) Designated stop signs________ (66) other________ Location of signal device (67) which side of track ________ (68) centre of road________ (69) right—left side of road (70) overhead________ Did (71) employes________ (72) devices________ properly function? (73) Are hours of protection limited?________ (state limits)________________________

WARNINGS Was (74) engine bell rung________ (75) where terminated________ (76) engine whistle blown________ (77) where terminated________ Did wind carry sound (78) toward________ (79) away from________ driver? (80) Headlight burning________ (81) dim ________ (82) bright________ (83) Could fireman sound alarm whistle________ (84) Did he________ (85) What other warnings given traveler________________ ________________________________

DRIVER Was (86) driver________ (87) other persons in vehicle________ familiar with crossing? (88) Name of driver ________________ Age________ (89) Name of owner________________ (90) What, if anything, did the driver say at time of accident as to cause?________________

DRIVER'S VIEW (91) Was view unobstructed within 100 feet of track________ (92) Within 50 feet________ (93) At 100 feet from crossing how far could train be seen?________ (94) At fifty feet________ (95) Name obstruction and distance from track________________ (96) Removable from Co property? ________ (97) What, in/on auto, limited sideview?________ (98) Was windshield obstructed?________

(over)

(Fig. 1)

VEHICLE (99) Direction bound________ Vehicle approached from side of (100) engineman________ (101) fireman________ (102) Speed of vehicle approaching crossing________m p h (103) Did vehicle overtake moving or standing vehicles within 200 feet of crossing?________ (104) Did vehicle stall on track?________ how long________ Cause________ (105) Was vehicle transporting inflammables, explosives, etc ?________ Vehicle ran into (106) engine________ (107)________car from engine Kind of vehicle (108) passenger closed________ (109) open________ (110) bus________ (111) truck________ (112) other________ Were vehicle (113) brakes________ (114) equipment________defective? (115) Rated passenger capacity of vehicle________ (116) No of persons in it________ (117) Were vehicle headlights burning?________

CASUALTIES

Classification	NUMBER OF PERSONS KILLED		INJURED	
Driver	(118)	________	(119)	________
Passenger in vehicle	(120)	________	(121)	________
Other Person	(122)	________	(123)	________
Passenger on train	(124)	________	(125)	________
Employe on train	(126)	________	(127)	________
Other Persons on train	(128)	________	(129)	________
Other R R employe	(130)	________	*(131)	________

* This will cover casualties to employes on duty due to vehicle striking employes but having no contact with company property.

(132) Was company property (gates, etc)________ (133) equipment damaged?________ (134) Cost $________ (135) Average number of trains over crossing daily________ (136) Average number of vehicles over crossing daily________ (137) Constructive suggestions________

(138) Identifying numbers of other accidents at this crossing________

REMARKS:

Symbols for (5) Weather

(A) Fair
(B) Cloudy
(C) Fog
(D) Rain
(E) Snow

Symbols for signal termination (77) Whistle (75) Bell

(A) At Crossing
(B) Within 100' of Crossing
(C) Within 500' of Crossing
(D) Within 1000' of Crossing

Date________

REPORT SUBMITTED BY ________

Location________

Title________

Each detail is important for study purposes Where nature of question permits, answer should be Yes or No.

(Fig. 2)

REPORT OF SPECIAL COMMITTEE ON CLEARANCES

A. R. WILSON, Iron and Steel Structures *(Chairman)*;
C. W. BALDRIDGE, Roadway;
J. V. NEUBERT, Track;
A. L. SPARKS, Buildings;
H. AUSTILL, Wooden Bridges and Trestles;
C. P. RICHARDSON, Masonry;
FRANK RINGER, Grade Crossings;
W. M. POST, Signals and Interlocking;
E. H. BARNHART, Rules and Organization;
R. C. BARDWELL, Water Service and Sanitation;
H. L. RIPLEY, Yards and Terminals;
H. M. BASSETT, Electricity;
L. P. KIMBALL, Shops and Locomotive Terminals;
J. E. ARMSTRONG, Assistant Chief Engineer, Canadian Pacific Railway (representing Canadian Practice);

Committee.

To the American Railway Engineering Association:

Your Committee respectfully submits the following as its report.

Clearance diagram for Bridges and Tunnels—Fig. 1.

Clearance diagram for Buildings and Sheds—Fig. 2.

Clearance diagram for Warehouse and Enginehouse Doors—Fig. 3.

Clearance diagram for Platforms—Fig. 4.

(a) The clearances on straight track shall not be less than those shown.

(b) On curved track the clearances shall be increased to allow for the overhang and the tilting of a car 80 ft. long, 60 ft. between centers of trucks and 14 ft. high.

(c) The superelevation of the outer rail being in accordance with the recommended practice of the American Railway Engineering Association.

(d) The distance from top of rail to top of ties shall be taken as 8 inches.

(e) Legal requirements to govern when in excess of dimensions shown.

The information contained in this report pertaining to Buildings, etc., as shown in Fig. 2, 3 and 4 was developed by Committee VI—Buildings.

As to assignment covering clearances as affected by half through inter-track girders and other structures; representatives of this Committee and the Car Construction Committee—A.R.A. have issued a questionnaire covering the outline of a proposed standard box car, information covering which when received will enable your Committee to more intelligently prepare the diagram as covered by this assignment. As the replies to the questionnaire are incomplete, this subject will not be reported at this time.

Action Recommended

That the clearance diagrams, Fig. 1, 2, 3 and 4, and paragraphs a, b, c, d and e be approved and the revisions substituted for the present recommendation in the Manual.

Respectfully submitted,

THE SPECIAL COMMITTEE ON CLEARANCES,

A. R. WILSON, *Chairman.*

Bulletin 329, September, 1930.

A

CLEARANCE DIAGRAM FOR BRIDGES AND TUNNELS

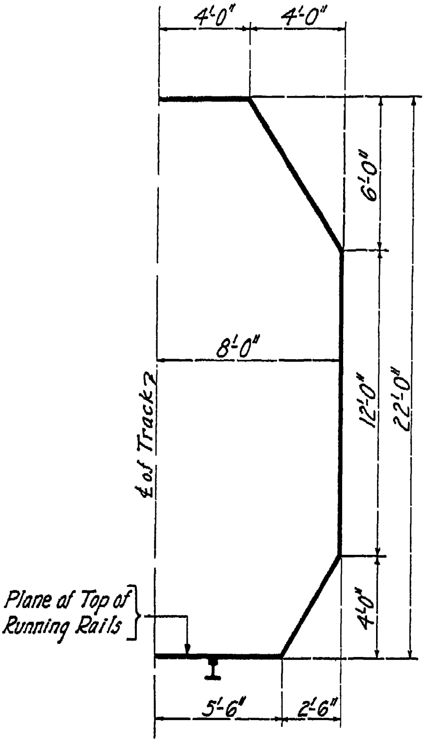


FIGURE 1

CLEARANCE DIAGRAM
FOR
BUILDINGS AND SHEDS

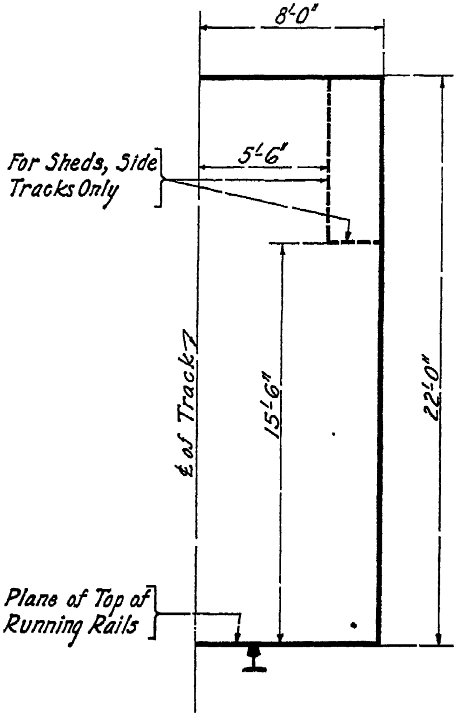


FIGURE 2

CLEARANCE DIAGRAM FOR WAREHOUSE AND ENGINE HOUSE DOORS

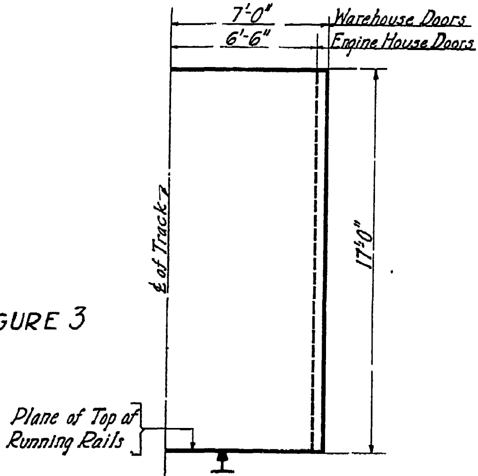


FIGURE 3

CLEARANCE DIAGRAMS FOR PLATFORMS

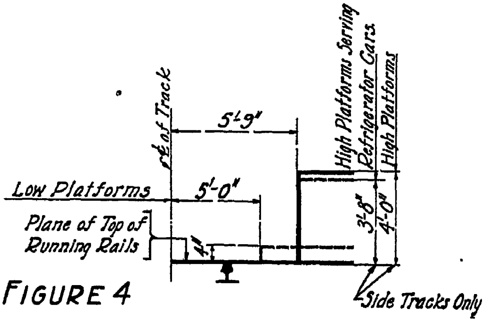


FIGURE 4

REPORT OF COMMITTEE II—BALLAST

A. P. Crosley, *Chairman;*
G. G. Amory,
G. J. Bell,
O. P. Chamberlain,
H. B. Christianson,
W. E. Colladay,
C. J. Coon,
R. C. Dunlay,
M. I. Dunn,
W. L. Foster,
A. T. Goldbeck,
Daniel Hubbard,
A. A. Johnson,
W. C. Kegler,
A. D. Kennedy,

C. E. Dare, *Vice-Chairman;*
S. H. Osborne,
W. W. Patchell,
H. M. Righter,
P. T. Robinson,
W. A. Roderick,
E. I. Rogers,
S. A. Seely,
J. A. Snyder,
C. B. Stanton,
J. W. Stone,
H. E. Tyrrell,
Stanton Walker,
A. H. Woerner,
C. H. Zentmyer,

Committee.

To the American Railway Engineering Association:

Your Committee respectfully presents herewith its report on the following subjects:

(1) Revision of Manual.

(2) Specifications for prepared gravel ballast, including best method of testing for hardness, abrasion and resistance to weathering (Appendix A).

(3) Specifications for stone ballast, including best method of testing for hardness, abrasion, and resistance to weathering (Appendix B).

(4) Shrinkage of ballast.

(5) Relative service life of stone, slag and prepared gravel and other kinds of ballast.

(6) Determine the answer to the question: What is ballasted track? (Appendix C).

Action Recommended

(1) The Committee has had under consideration several matters looking to a revision of the Manual particularly as to depth of ballast. This has not progressed sufficiently to warrant any recommendations at this time.

(2) That Appendix A be accepted as information.

(3) That the recommendations of Sub-Committee, Appendix B, dealing with specifications for stone ballast be approved and included in the Manual. That the balance of the report be accepted as information.

(4) The Committee had hoped to submit information on the tests which have been conducted, but felt that it was best to delay submission for another year.

(5) The Committee has given this subject serious consideration and formulated a questionnaire which was sent out. From the replies received it is evident that little can be hoped for, at least for the present. The Committee has asked that the subject be assigned in a slightly different form and it is hoped that some valuable information may be obtained working along these lines.

(6) That the recommendations of Sub-Committee, Appendix C, be approved and included in the Manual.

Respectfully submitted,

The Committee on Ballast,

A. P. Crosley, *Chairman.*

Bulletin 329, September, 1930

Appendix A

(2) SPECIFICATIONS FOR PREPARED GRAVEL BALLAST, INCLUDING BEST METHOD OF TESTING, ETC.

C. B. Stanton, Chairman, Sub-Committee; W. L. Foster, W. C. Kegler, W. A. Roderick, Stanton Walker, S. A. Seely.

The Committee is attacking this problem in two parts: (1) consideration of requirements and methods of tests for grading and cleanness, and (2) consideration of methods of testing and requirements for hardness, abrasion and resistance to weathering.

The recommendations of the Committee for grading, cleanness, and methods of testing for these properties were reported before the last annual meeting and were adopted. It is believed that these recommendations constitute a satisfactory tentative specification covering these factors. It is considered desirable to avoid making changes in them until opportunity has been had to learn from experience as to their suitability when applied in practice. It is proposed that during 1931 a canvass of the roads be conducted to determine the extent of the uses of these specifications. Consideration is also being given to their effect on the economics of the production of prepared gravel ballast, and with the view of obtaining information on this phase of the subject, it is intended that the canvass of the various railroads be supplemented with a canvass of the gravel producers in those localities where the A.R.E.A. specifications are applied.

The second part of the problem (consideration of methods of testing and requirements for hardness, abrasion and resistance to weathering) has been studied and considerable preliminary work has been carried on in two laboratories. Samples of gravel ballast have been submitted by several railroads and gravel producers for a study of the physical characteristics which will aid the Committee in the development of methods of tests and the formulation of specification requirements.

It was pointed out in last year's report that laboratory test results alone would not permit the fixing of suitable specification limits. It is necessary for such information to be supplemented by a study of service records, before authoritative conclusions can be reached. Accordingly letters were written to Engineers who had had experience with the grades tested in the laboratory, requesting information along the following lines:

(1) Strength in track support, or resistance to breaking down under traffic.
(2) Stability, or resistance to displacement in the road-bed.
(3) Durability, or resistance to disintegration due to weathering.
(4) Drainage properties.
(5) Maintenance and chief cause for need of maintenance.

Unfortunately, the information obtained to date from this correspondence has been meager. Some of the replies discussed gravel ballast in general, while the Committee was interested in obtaining information on the specific gravel in question in order that results of field observations might be compared with the laboratory results. A few Engineers gave complete answers to the questions. It is felt that comprehensive information along these lines is required before definite recommendations can be made for either specification limits or methods of tests.

Appendix B

(3) SPECIFICATIONS FOR STONE BALLAST, INCLUDING BEST METHOD OF TESTING FOR HARDNESS, ABRASION AND RESISTANCE TO WEATHERING

H. M. Righter, Chairman, Sub-Committee, O. P. Chamberlain, C. J. Coon, R. C. Dunlay, J. A. Ellis, W. L. Foster, A. T. Goldbeck, A. A. Johnson, J. F. Montgomery, W. W. Patchell.

Your Committee as the preliminary step in the investigation of the assigned subject reviewed the present specifications for Stone Ballast appearing in the 1929 Manual, and it is felt that the specifications should be revised and rearranged. They feel that as a matter of arrangement there should be a separation of the test requirements from the methods of test. This seems to be desirable for in this form the test requirement portion could be written directly into the specifications of individual railroads and in these individual specifications the test methods could be referred to as those of the A.R.E.A. They make the suggestion that the present specifications for Stone Ballast as appearing in the 1929 Manual be withdrawn and the following specifications substituted therefor:

SPECIFICATIONS FOR STONE BALLAST

1. General Characteristics

Crushed stone for use as ballast shall be composed of hard, tough, durable rock of high resistance to wear and low cementing value. It shall be clean and well graded between the maximum and minimum sizes.

2. Apparent Specific Gravity and Weight per Cubic Foot

The apparent specific gravity and weight per cubic foot shall be not less than .... and .... pounds, respectively.

3. Absorption

The absorption shall not exceed .... per cent.

4. Toughness

The toughness shall be not less than .....

5. Percentage of Wear

The percentage of wear shall not exceed .... per cent.

6. Cementing Value

The cementing value shall not exceed .... pounds.

7. Soundness

All rock for stone ballast shall be subjected to five cycles of the sodium sulphate soundness test. If, at the end of the test, more than (a) per cent of the sample has disintegrated or if more than (b) per cent of the fragments by weight show serious spalling, cracking or checking, the sample shall be rejected unless rock from the same source has been proven by service to have satisfactory durability.

Note.—It is suggested that the following values be inserted in the above specifications:

(a) = 10 per cent,
(b) = 20 per cent.

8. Frequency

Tests may be made from time to time at the option of the purchaser, and especially when new strata are being opened up for crushing into ballast.

9. Selection of Samples

Each stratum of a quarry shall be tested separately and not averaged with any other stratum (A.S.T.M.D. 75-22).

10. Averaging

For obtaining the values for physical tests, the average results of the numbers of specimen stated in the following table shall be taken:

Kind of Tests	*Weight*	*Percentage of Wear*	*Toughness*	*Cementing Value*	*Soundness*
No. of Tests	5	5	5	5	5

11. Place of Tests

Such tests as are deemed necessary shall be made at a testing laboratory selected by the purchaser, but visual inspection and other tests shall be made at the place of manufacture prior to shipments as often as considered necessary.

PRODUCTION REQUIREMENTS

12. Size

Stone for ballast shall be so prepared that when tested by means of laboratory screens having circular openings, it will meet the following size requirements:

Passing (a) (maximum size) 95 per cent.
Passing (b) (intermediate size) 40-75 per cent.
Passing (c) (minimum size) 0-5 per cent.

It is recommended that the following values be used:

$a = 2.75$ in.
$b = 1.25$ in.
$c = 0.75$ in.

13. Handling

Broken stone for ballast should be delivered from the screens directly to the cars or to clean bins provided for the storage of the output of the crusher.

Ballast must be loaded into cars which are in good order and tight enough to prevent leakage and waste of material and which are clean and free from sand, dirt, rubbish, or any other substance which would foul or damage the ballast material.

14. Cleaning

The ballast shall be free from dirt, loam, dust or rubbish. When the rock is of such a nature that it does not become clean without preliminary scrubbing, a scrubbing machine shall be provided at the quarry.

15. Defect Found After Delivery

As it is impracticable to inspect all the ballast loaded in cars, carloads of defective material arriving at the site for unloading, and not previously inspected, shall be rejected and returned to the manufacturer, who must pay the freight charges both ways. If unloaded prior to discovery of defectiveness, payment without return of the rejected ballast shall be refused to the manufacturer.

16. Inspection

Inspectors representing the purchaser shall have free entry to the works of the manufacturer at all times while the contract is being executed, and shall have all reasonable facilities afforded them by the manufacturer to satisfy them that the ballast is prepared and loaded in accordance with the specifications and contracts.

In case the inspection develops that the material which has been or is being loaded is not according to specifications, the inspector shall notify the manufacturer to stop further loading and to dispose of all cars under load with defective material.

17. Measurement

Ballast material may be reckoned in cubic yards or by tons, as expedient. Where ballast material is handled in cars, the yardage may be determined by weight, after ascertaining the weight per cubic yard of the particular stone in question by careful measurement and weighing of not less than five cars filled with the material or the tonnage may be determined for subsequent cars by measurement and converting the yardage into tonnage by the use of the weight per yard as determined above.

NOTE. 1.—The following are typical values for physical characteristics of high quality stone:

	Limestone	*Trap*
Apparent Specific Gravity	2.68	2.81
Weight per cubic foot (solid)	168	175
Toughness, not less than	10	15
Per cent wear, not more than	5	3
Cementing value, not more than	4	1
Absorption, not more than	1.0	0.5

NOTE 2.—Rock types other than those above mentioned are also of high quality for ballast. When it is not economically feasible to procure rock of the highest quality, lower quality material may be used and lesser requirements than the above should be inserted in the specifications.

TEST METHODS

18. Apparent Specific Gravity

The apparent specific gravity shall be determined in the following manner:

(1) The sample, weighing approximately 2.2 lb. (1000 g.) and composed of pieces approximately cubical or spherical in shape and retained on a screen having 0.5 in. (1.27 cm.) circular openings, shall be dried to constant weight at a temperature between 212 and 230 deg. Fahr. (100-110 deg.), cooled, and weighed to the nearest 0.5 g. Record this weight as weight "A." In the case of homogeneous materials, the smallest particles in the sample may be retained on a screen having 1.25 in. circular openings.

(2) Immerse the sample in water for 24 hours, surface-dry individual pieces with aid of a towel or blotting paper, and weigh. Record this weight as weight "B."

(3) Place the sample in a wire basket of approximately 0.25 in. mesh and about 5 in. (12.7 cm.) and 4 in. (10.3 cm.) deep, suspended in water from center of scale pan, and weigh. Record the difference between this weight and the weight of the empty basket suspended in water as weight "C." (Weight of saturated sample immersed in water.)

NOTE.—The basket may be conveniently suspended by means of a fine wire hung from a hook shaped in the form of a question mark with the top end resting on the center of the scale pan.

(4) The apparent specific gravity shall be calculated by dividing the weight of the dry sample (A) by the difference between the weights of the saturated sample in air (B) and in water (C) as follows:

$$\text{Apparent Specific Gravity} = \frac{A}{B - C}$$

(5) Attention is called to the distinction between apparent specific gravity and true specific gravity. Apparent specific gravity includes the voids in the specimen and is therefore always less than or equal to, but never greater than the true specific gravity.

19. Weight per Cubic Foot

The weight per cubic foot solid shall be calculated by multiplying the apparent specific gravity by the weight of a cubic foot of water (62.35 lb.).

Weight per cubic foot = apparent specific gravity $\times$ 62.35 lb.

20. Absorption

The absorption may be calculated from the values obtained in making the above test for apparent specific gravity or the test may be made separately by the method given in Articles 1 and 2 of Section 18.

Per cent absorption is then calculated by subtracting the dry weight (A) from the saturated weight (B) and dividing by the dry weight (A), multiplying the quotient by 100.

$$\text{Per Cent Absorption} = \frac{B - A}{A} \times 100.$$

21. Toughness

A piece of solid rock from which a cylindrical core perpendicular to the bedding plane of the rock 0.98 in. by 0.98 in. (25 mm. by 25 mm.), can be cut with a diamond core drill, and the ends ground plane shall, after drying, be held on an anvil, weighing not less than 110.23 lb. (50 kg.) in the Page impact machine, like a miniature pile driver, under a plunger with sphere shaped striking surface of 0.39 in. (1 cm.) radius, which is struck by a hammer when released weighing 4.4 lb. (2 kg.). The test begins with a 0.39 in. (1 cm.) fall of the hammer for the first blow, and continues with an increased fall of 1 cm. for each succeeding blow until the test piece fails, the number of blows and height being the same and representing the toughness of the rock.

22. Soundness

Fifty pieces of rock, each weighing approximately 0.22 lb. (100 grams) shall be subjected to cycles of immersion in a solution of sodium sulphate and drying in accordance with the following procedure:

Preparation of Solution—The solution shall be prepared by dissolving commercial sodium sulphate in water at 80 to 85 deg. Fahr, allowing the solution to cool to 70 deg. Fahr. at which time crystals of sodium sulphate shall have formed in the solution. Pour off the solution so prepared, excluding the crystals of sodium sulphate and use this solution for the tests.

Immerse the stone in the solution 18 to 19 hours' during which time the temperature of the solution shall be maintained at 70-75 deg. Fahr. and the pan shall be covered to prevent evaporation. An earthenware or agate-ware vessel shall be used.

At the end of 18 or 19 hours, remove specimens and place immediately in a shallow pan or tray. Immediately place tray in oven preheated to a temperature of 212-221 deg. Fahr. (100-105 deg. Cen.) Maintain oven at that temperature for 4 hours, after which period remove samples and allow to cool 1 or 2 hours to air temperature. At end of cooling period reimmerse specimens in solution. One immersion and one period of dry and cooling constitutes a cycle.

23. Wear Test

Apparatus. 1. The testing machine shall consist of one or more hollow iron cylinders; closed at one end and furnished with a tightly fitting iron cover at the other. These cylinders shall be 7.87 in. (20 cm.) in diameter and 13.40 in. (34cm.) in depth inside, and shall be mounted on a shaft at an angle of 30 deg. with the axis of rotation of the shaft.

Preparation of sample. 2. At least 30 lb. of coarsely broken stone shall be available for a test. The rock to be tested shall be broken in pieces as nearly uniform in size as possible, and as nearly 50 pieces as possible shall constitute a test sample.

Procedure. 3. The total weight of rock in a test shall be within 0.022 lb. (10 grams) of 11.0 lb. (5 kg.). All test pieces shall be washed and thoroughly dried before weighing. Ten thousand revolutions, at a rate of between 30 and 33 per minute, shall constitute a test. Only the percentage of material worn off which will pass through a 0.005 in. (0.16 cm.) mesh sieve shall be considered in determining the amount of wear.

(A.S T.M. D2-26 slightly modified.)

24. Cementing Value

One and one-tenth lb. (one-half kg.) of stone which can be crushed to pea size, shall be placed (dry) in a ball mill which contains two steel shot weighing 20 lb. (9.07 kg.) each, given 5000 revolutions at the rate of thirty (30) revolutions per minute and the dough resulting from a mixture of the dust screened through a 100 mesh sieve, and water, placed in an air tight vessel for three (3) hours and then rekneaded, shall be made into six cylindrical briquettes 0.98 in. (25 mm.) in diameter and 0.98 in. (25 mm.) in height formed under a pressure of 1877.5 lb. per sq. in. (132 kg.) after which they shall be allowed to dry 20 hours in air, four hours in a hot air bath of 212 deg. Fahr. (100 deg. Cent.) and then cooled for twenty minutes in a desiccator, and immediately tested in a machine for ascertaining the crushing strength in pounds per sq. in., which is the measure of the cementing value of the rock. The average of five (5) determinations should be taken.

Throughout the suggested revised specifications it will be noted that the requirements have been left blank. It was not thought feasible or desirable to attempt to write a specification with hard and fast requirements, as natural materials occurring over a wide area differ to a marked degree. The Committee is pursuing the study of this subject and hopes to have at some later date suggestions as to what it considers suitable for insertion in the blanks.

The Committee in the preparation of the above specifications and in its work on this assignment has confined their efforts to top-ballast as distinguished from sub-ballast.

Appendix C

(6) DETERMINE THE ANSWER TO THE QUESTION: WHAT IS BALLASTED TRACK?

H. E. Tyrrell, Chairman, Sub-Committee; C. J. Coon, J. A. Ellis, R. L McCormick, E. I. Rogers.

This Committee has reviewed previous work on the assignment, has considered the report to the 1930 Convention, appearing on pages 767 and 768 of Volume 31 of the Proceedings, and has handled the question with many members of the Association having widely differing interests in it.

The report to the 1930 Convention illustrates how the volume and nature of traffic of a railway, or a section of a railway, might influence that railway's conception of what constitutes Ballasted Track. It also refers to the definitions of Track, Ballast, Sub-Ballast and Top-Ballast (pages 197 and 93 of the 1929 Manual) and mentions specifically the broadness of the whole question.

Taking these points into consideration, as well as the additional information and opinions developed this year, we desire to concur in the report made to the 1930 Convention, but recognize that the definition submitted in that report might restrict the use of the term "Ballasted Track" to such track as would be considered fully or completely ballasted and, therefore, suggest the following as an answer to the question:

Ballasted track is track to which ballast has been applied in its proper relative position.

■

REPORT OF COMMITTEE XX—UNIFORM GENERAL CONTRACT FORMS

J. C. IRWIN, *Chairman;*
C. FRANK ALLEN,
E. H. BARNHART,
CALVIN BARTLETT,
W. H. BRAMELD,
B. S. DICKERSON,
R. P. EUBANK,
W. D. FAUCETTE,
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F. L. NICHOLSON, *Vice-Chairman;*
A. A. MILLER,
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H. A. PALMER,
CHARLES SILLIMAN,
HUNTINGTON SMITH,
E. L. TAYLOR,
J. S. THORP,
C. A. WILSON,
JOHN WORLEY,

Committee.

To the American Railway Engineering Association:

Your Committee respectfully presents herewith report covering the following subjects:

(1) Revision of Manual (Appendix A).

(2) Cost-plus methods in construction contracts (Appendix A).

(3) Form of agreement for the purchase of electrical energy in large volume (such as required for traction purposes), collaborating with Committee XVIII—Electricity (Appendix B).

(4) Form of agreement for the organization and operation of a joint passenger terminal project, collaborating with Committee XIV—Yards and Terminals (Appendix C).

(5) Special forms of contracts for maintenance-of-way work (Appendix A).

Action Recommended

(1) That no revision of the Manual be made at this time.

(2) That Appendix I and Appendix II to the "Form of Cost-Plus Percentage Construction Contract" as recommended in Appendix A of this report, as alternates for the methods of providing for the contractor's fee and covering "Cost-Plus a Fixed Fee" and "Cost-Plus a Stated Sum with Adjustments for Varying Conditions" be approved for publication in the Manual.

(3) That the study of a form of agreement for the purchase of electrical energy in large volume (such as required for traction purposes), reported in Appendix B, be continued.

(4) That the study of a form of agreement for the organization and operation of a joint passenger terminal project, reported in Appendix C, be continued.

(5) That the conclusion in Appendix A that no special forms of contract for maintenance-of-way work are necessary and that none be recommended for publication in the Manual, be approved and that the subject be discontinued.

Respectfully submitted,

THE COMMITTEE ON UNIFORM GENERAL CONTRACT FORMS,

J. C. IRWIN, *Chairman.*

Bulletin 329, September, 1930.

Appendix A

(1) REVISION OF MANUAL
(2) COST-PLUS METHODS IN CONSTRUCTION CONTRACTS
(5) SPECIAL FORMS OF CONTRACTS FOR MAINTENANCE-OF-WAY WORK

Charles Silliman, Chairman, Sub-Committee; C. Frank Allen, E. H. Barnhart, R. P. Eubank, W. D. Faucette, F. H Fechtig, O. K. Morgan, C. B. Niehaus.

(1) REVISION OF MANUAL

Your Committee has no revisions to recommend at this time.

(2) COST-PLUS METHODS IN CONSTRUCTION CONTRACTS

Your Committee submits the following report on Cost-Plus Methods in Construction Contracts, supplementing the form of Cost-Plus Percentage Construction Contract printed in A.R.E.A. Manual for 1929.

A study of general practice and reports from many railways shows that a Cost-Plus Fixed Fee Contract without modifications permitting adjustments in the Contractor's fee for variations in the cost or in the quantities involved in the work, is very seldom used. However, the Committee has prepared the wording of such modification for those who wish to use it.

The Committee also finds that the so-called Cost-Plus Percentage with a Fixed Maximum Contract is seldom used and considers it inadvisable to present such a modification for the reason that any variation from a Fixed Fee basis can best be provided by the use of a so-called Sliding Scale Contract.

The Committee presents such a modification in the provision for a Cost-Plus a Stated Sum with Adjustments for Varying Conditions.

The Committee points out that the use of the term "Fixed Fee" where changes in the fee are provided for in the contract is an incorrect use of the term and is apt to be misleading.

Conclusions

Where limitations in the strictly Cost-Plus Percentage basis are desirable, the Committee recommends as best practice that the agreements take the form of:

(a) Cost Plus a Fixed Fee.
(b) Cost Plus a Stated Sum with Adjustments for Varying Conditions.

The Cost Plus Fixed Fee form should not be used where there is a likelihood of there being any change in the amount or conditions of the work involved.

Instead of rewriting the adopted form of Cost Plus Percentage Construction Contract as printed in A.R.E.A. Manual for 1929, provision can be made for desired limitations by the attachment of an appendix to the standard form. It submits as suggestions for such the following: Appendix I—Cost Plus Fixed Fee, and Appendix II—Cost Plus a Stated Sum with Adjustments for Varying Conditions.

Appendix I to Form of Cost-Plus Percentage Construction Contract

COST PLUS A FIXED FEE

Where work is done on the basis of Cost Plus a Fixed Fee, the A.R.E.A. adopted form for Cost Plus Percentage Construction Contract should be modified as follows:

Section 42—Fee (Fixed Sum)

The Contractor shall be paid in addition to the costs as defined in Sections 39 and 40 the fixed sum of $........... as his fee for services rendered.

Appendix II to Form of Cost-Plus Percentage Construction Contract

COST PLUS A STATED SUM WITH ADJUSTMENTS FOR VARYING CONDITIONS

Where work is done on the basis of "Cost Plus a Stated Sum with Adjustments for Varying Conditions," the A.R.E.A. adopted form for Cost Plus Percentage Construction Contract should be modified as follows:

Section 42—Fee (A Stated Sum with Adjustments for Varying Conditions)

a. The Contractor shall be paid in addition to the costs as defined in Sections 39 and 40 the stated sum of $..........., herein referred to as the Basic Fee, based on the Cost of the Work which has been estimated by the Contractor at $..........., as per schedule of quantities and unit prices hereto attached constituting and herein referred to as the Basic Cost.

b. Should the quantities of work done vary from those in the schedule constituting the Basic Cost, then the Basic Cost shall be adjusted by applying to the quantities of work actually done the unit prices included in the schedule and a Revised Basic Cost established. In the same manner, a new Basic Fee shall be established by applying to the quantities of work done the unit prices submitted for his fee or commission and a Revised Basic Fee established.

c. Should any additional work be required which is not provided for in the schedule of quantities and items of work, the Engineer may agree in writing with the Contractor as to the items and quantities of such additional work, the estimated cost and the amount of the Contractor's fee or commission per unit of additional work. In such event the amounts agreed upon shall be added to the schedule constituting the Basic Cost and the Basic Fee, and the final amount due the Contractor shall then be determined in the same manner as described in Paragraph d. of this Section.

d. Upon the completion of the work the actual Cost shall be determined and if it be less than the revised Basic Cost as above described, then the Contractor shall receive in addition to the revised Basic Fee. fifty per

cent (50%) of the savings, but in no case shall the Contractor's share of the savings exceed an amount equal to fifty per cent (50%) of the Revised Basic Fee as finally determined.

Should the actual Cost of the Work as determined upon the completion of the work be more than the final Basic Cost as above described, then the Contractor's Revised Basic Fee shall be reduced by fifty per cent (50%) of such excess and the remainder constitute his fee or commission, but in no case shall the Contractor's Revised Basic Fee be reduced more than fifty per cent (50%).

e. Should any additional work be authorized by the Engineer and which is not provided for in the schedule of quantities and items of work, or as supplemented by Paragraph c. of this Section, the Contractor shall be reimbursed at actual cost of the work, and in addition thereto a fee of .... per cent on items of cost as defined in Section 39.

(5) SPECIAL FORMS OF CONTRACTS FOR MAINTENANCE-OF-WAY WORK

Your Committee reports that from a study of this matter and returns from many railways, it is not indicated that there is any necessity for such a special form of contract nor is there much interest among the railways in having it developed.

In connection with this, the subject of a special form for Dredging Contracts was investigated and the conclusion reached by the Committee that the report of A.R.E.A. Committee XXV covering dredging specifications renders a special form of contract unnecessasry, as these specifications in connection with the recommended forms of contract in the Manual furnish the railways all the information and direction needed.

Conclusion

That no special forms of Contracts for Maintenance-of-Way Work are necessary and that none be recommended for publication in the Manual.

Appendix B

(3) FORM OF AGREEMENT FOR THE PURCHASE OF ELECTRICAL ENERGY IN LARGE VOLUME (SUCH AS REQUIRED FOR TRACTION PURPOSES), COLLABORATING WITH COMMITTEE XVIII—ELECTRICITY

F. L. Nicholson, Chairman, Sub-Committee; W. H. Brameld, S. L. Mapes, H. A. Palmer, Huntington Smith, E. L. Taylor, J. S. Thorp.

Your Committee reports progress with Form of Agreement for the Purchase of Electrical Energy in Large Volume. The tentative draft of form is in the hands of Sub-Committee, collaborating with a Sub-Committee of Committee XVIII—Electricity. It is not at the present time in shape for presenting to the Association.

It is recommended that the subject be continued.

Appendix C

(4) FORM OF AGREEMENT FOR THE ORGANIZATION AND OPERATION OF A JOINT PASSENGER TERMINAL PROJECT, COLLABORATING WITH COMMITTEE XIV—YARDS AND TERMINALS

W. G. Nusz, Chairman, Sub-Committee; Calvin Bartlett, B. S. Dickerson, A. C. Jackson, J. S. Lillie, A. A. Miller, C. A. Wilson, John Worley.

Your Committee reported progress at the 1930 convention and submitted at that time a preliminary draft of the Form of Agreement for the Organization and Operation of a Joint Passenger Terminal Project, for criticism and suggestion. This draft will be found in Bulletin 320, pages 494 to 524, both inclusive.

A number of very helpful suggestions have been received, during the past year, from both the members of the Association and others. The Committee has continued to diligently study the subject, collaborating with Committee XIV—Yards and Terminals, and the two Committees are now practically in accord.

Your Committee feels that the importance of the assignment is such that every effort should be made to obtain as many suggestions as possible before a final form is submitted to the Association. At the present stage of development it is not considered necessary to reprint the form at this time, and your Committee again submits the agreement, as printed in Bulletin 320, for information and discussion.

REPORT OF SPECIAL COMMITTEE ON STANDARDIZATION

J. C. IRWIN, *Chairman;*
LOUIS YAGER, *Vice-Chairman;*
W. C. CUSHING, *Honorary;*
COL. WM. G. ATWOOD,
H. AUSTILL,
C. W. BALDRIDGE,
R. C. BARDWELL,
E. H. BARNHART,
F. L. C. BOND,
W. J. BURTON,
A. P. CROSLEY,
ROBERT H. FORD,
C. C. HAIRE,
L. P. KIMBALL,
C. R. KNOWLES,
J. R. W. AMBROSE, *Vice-Chairman;*
F. R. LAYNG,
J. V. NEUBERT,
W. M. POST,
C. P. RICHARDSON,
FRANK RINGER,
H. L. RIPLEY,
F. C. SHEPHERD,
A. L. SPARKS,
EARL STIMSON,
J. E. TEAL,
F. M. THOMSON,
A. R. WILSON,
S. WITHINGTON,

Committee

To the American Railway Engineering Association:

Your Committee respectfully presents the following report:

The progress of Standardization since the appointment of the Committee in 1919 is clearly indicated in the reports of the Committee published in Proceedings beginning with Vol. 21, year 1920, and extending through Vol. 31, year 1930, reports having been made in all years except 1925 and 1926. These reports show that there has been very great advance in the general acceptance of the idea of Standardization in fields where it will promote safety, economy and facility. The reports of the past four years are most comprehensive in explanation of the machinery of standardization, the organization of standards associations and their co-operative activities, and the extension of standardization in industrial fields.

Your Committee considers its functions to be:

To encourage the use of A.R.E.A. Recommended Practices in the railway field, and to promote, as National Standards, such subjects as may be selected for sponsoring by the Board of Direction, from which it receives its instructions.

To maintain contact with Standardization bodies and keep the Association informed on important matters developed by such contact.

No subjects have been referred to this Committee for consideration for sponsoring in the American Standards Association as National Standards during the year.

Approval of A.R.E.A. Manual by the American Railway Association—Extension of Uniform Practice

In connection with the promotion of the use of A.R.E.A. Recommended Practice, very definite progress has been made by the endorsement and approval by the American Railway Asssociation of the material in the A.R.E.A. Manual, 1929 edition, as shown on the title page and in the last paragraph of the "Foreword." This should be the greatest possible aid in the extension of uniform practice.

Bulletin 329, September, 1930.

The members of this Association are the agents through which the use of its Recommended Practice will be more generally extended. Reference to the Manual for information or for guidance on procedure, constitutes use which amply warrants its existence, whether the basic "recommended practice" is followed absolutely or not. In many cases where a matter of design or other practice affects no other railway and no outside party, modifications of recommended practices can be made to suit the user without question of detriment to others.

In matters affecting two railways, each one having relations with other railways, the greater importance of uniform practice is clear.

In matters where various railways have similar interests with industries which they serve, manufacturers from whom they purchase, contractors with whom they deal, or with the public, the desirability for uniform practice is emphasized, so that the acts of one party in interest in one case will not be detrimental to the parties in other similar cases.

While limitations on such uniform practices must be recognized, yet, if individual users are willing to subordinate some of their views for the general good, there will be much more extensive acceptance of the material in the Manual, *as recommended.*

To aid in determining the relative importance of the general use of the Recommended Practices in the Manual, the classification of uses similar to that printed in the report of this Committee last year, Bulletin 320, (Vol. 31) is here given.

Classification of A.R.E.A. Recommended Practices According to Use

(A) Those which concern only the individual railway; such as roadway and ballast sections, design of culverts, etc.

(B) Those which concern relations between two or more railways; such as agreements for trackage rights, interlocking, etc.

(C) Those which concern the railway and the industries or individuals which it serves; such as agreements for industry tracks, lease agreements, etc.

(D) Those which concern the railway and the manufacturers of railway supplies; such as track and signal designs and specifications, etc.

(E) Those which concern relations between the railway and its contractors or public service corporations; such as construction contracts, agreements for the purchase of electrical energy, for wire line crossings, etc.

(F) Those which concern the relations between the railways and the general public; such as highway crossing protection, etc. Manufactured articles in this class would also be in Class D.

It is not intended actually to list the subjects in the Manual under these headings but the classification may clarify views on the importance of the general use of any of the material in the Manual and may aid in the selection of special subjects which it would be for the benefit of the railways to have presented to the American Standards Association for consideration as National Standards. Certainly it will tend to eliminate most of the subjects in the Manual from any such consideration. In most cases the endorsement and approval by the American Railway Association is sufficient.

The classification under these headings made by six Standing Committees, covering the subjects under their jurisdiction published last year in

the report of this Committee, Bulletin 320 (Vol. 31), pages 345 to 351, is illuminating.

It is apparent that subjects coming under Class A are merely for the purpose of being a guide to good practice and of saving time and money for the user.

In Class B, involving more than one railway and each one having relations with others, the benefit of a basic uniform practice with variations only as local conditions require, is evident. In some cases the recommended practices recognize the need for these local variations by providing alternates or by leaving such phases open.

In the other classes, the importance of uniform practice may be judged by the extent of the inter-relations of the interests concerned.

In order to facilitate the general adoption of practices in which the interests of the railways are involved with the interests of others, with whom they deal, it is important that the Standing Committees of this Association, to which subjects are asssigned in their Outline of Work, secure the co-operation, not only of the representatives of other Divisions or Sections of the American Railway Association, but also of those of other national organizations of public service corporations or of industries as far as practicable, so that when a practice shall have been submitted to and approved by the A.R.E.A., it will have the support of such other bodies concerned in its general use. Without such co-operation, their opposition might defeat the purpose of the establishment of such recommended practice.

Those who use the Manual should call to the attention of Committee Chairmen, any real objections they find to the use of any Recommended Practice so that such objections can be considered in the study of the revision of the Manual and any changes which appear necessary, to make the practice more generally acceptable, can be made by authorized procedure.

NATIONAL STANDARDIZATION

American Standards Association (A.S.A.)

If any Standing Committee of this Association decides that any subject is suitable for National Standardization beyond its approval as Recommended Practice and endorsement by the American Railway Association and that such standardization would be beneficial, it should bring the subject to the attention of the Board of Direction, A.R.E.A., with its recommendation and supporting data, for such further action as the Board may deem desirable.

The American Railway Association can act as sponsor to bring any such subject before the American Standards Association. In case of its acceptance for study, it becomes a "Project" of the American Standards Association and, through one of the methods of procedure provided in the by-laws of that association to insure due care in the development of standards, it finally comes before the Council of that association for approval The American Standards Association and its Standards Council do not, in themselves, formulate standards.

The A.S.A. publishes a Year Book which describes its organization and activities.

A.R.A Representation in A.S.A.

L. A. Downs, President, Illinois Central Railroad, Past-President A.R.E.A., is the member of the Board of Directors, American Standards Association, designated by the American Railway Association.

At present (1930) the A.R.A. has only one representative with two alternates on the A.S.A., these being appointed from Division IV—Engineering, as follows:

Representative—J. C. Irwin (who succeeded W. C. Cushing, resigned, June, 1930). Alternates—J. R. W. Ambrose and E. K. Post.

A large number of members of the A.R.E.A. are serving as members of Sectional Committees of the A.S.A. in the study of subjects for development as standards. A list of these members is filed with the Secretary, A.R.E.A., for reference.

Men appointed by other Divisions or Sections of the A.R.A. also are serving on these Sectional Committees.

Appendices A and B to this report show "American Standards approved by the A.S.A. for the period September 1, 1929, to September 1, 1930" and the "A.S.A. Technical Projects on Which the Railway Associations Are Now Co-operating."

With the connections here outlined, the representatives of the A.R.A. on A.S.A. and the numerous members of Sectional Committees are in a position to exert their influence against ill-advised standardization as well as to advance the interests of the railways in the creation and adoption of standards which will be of special value.

This year, the American Railway Association has appropriated $15,000 a year for a term of three years to assist in the work of the A.S.A., and consideration is now being given to the possibility of the appointment of representatives on the American Standards Association from Divisions of the American Railway Association other than Division IV—Engineering.

Canadian Engineering Standards Association (C.E.S.A.)

The C.E.S.A. operates on lines somewhat similar to the A.S.A.

Members of its "Main Committee" who are members of the A.R.E.A. are accredited in its records as follows:

F. L. C. Bond, Canadian National Railways
J. M. R. Fairbairn, Representing Institute of Civil Engineers
Lt. Col. C. N. Monsarrat, Consulting Engineer, Montreal
T. L. Simmons, Board of Railway Commissioners for Canada
A. F. Stewart, Canadian National Railways

The Canadian Pacific Railway is also represented on the Main Committee by J. A. Shaw.

Both the Canadian National Railways and the Canadian Pacific Railway Company are sustaining members of the C.E.S.A.

The C.E.S.A. publishes a Year Book which describes its organization and activities.

Other National Standardizing Bodies

In addition to the United States and Canada, each of the following countries has a national standardizing body: Austria, Australia, Belgium, Czechoslovakia, Denmark, Finland, France, Germany, Great Britain, Holland, Hungary, Italy, Japan, Norway, Poland, Roumania, Russia, Sweden and Switzerland.

International Standards Association (I.S.A.)

The I.S.A. had its beginning in an international conference held in New York in 1926. After three years of preparation, it was established in Zurich, Switzerland, in the spring of 1929 by formal action of sixteen national bodies.

Quoting from the A.S.A. Year Book: "In October, 1929, the Board of Directors of the American Standards Association decided unanimously that the A.S.A. should become a member of the I.S.A. in order that industry might have the benefit of close and systematic contact through an authoritative channel with industrial standardization in other countries."

"Through the I.S.A., the A.S.A. is co-operating with other national bodies in a regular exchange of information in regard to new projects, draft standards, etc. Each body maintains a file of, and acts as sales agent for, approved standards of other countries, thus making this information readily available to the industries of the country."

With the exception of Australia, Canada and Great Britain all of the countries which have National Standardization bodies are now members of the I.S.A.

The objects of this association are limited to co-operation in standardization rather than the promulgation of I.S.A. Standards.

No American member has yet been appointed on any of the I.S.A. technical committees.

Paris Conference

A conference under the auspices of the I.S.A. was held in Paris, May, 1930. Projects taken up by technical committees were as follows:

I. Paper Sizes
II. Technical Drawings
III. Twist Drills and Other Small Tools
IV. Test Pressures for the Acceptance of New Stationary Steam Boilers
V. Wrench Openings (width across flats of bolt heads and nuts)
VI. Rivets
VII. Coal—Classification of Sizes
VIII. Traffic Signals
IX. Petroleum Products—Nomenclature and Methods of Test
X. Fluid Meters

The Secretariat for Project IX—Petroleum Products, was assigned to the United States.

In addition to the above, new Committees were appointed to deal with Cast Iron and Steel, and Bronze and Brass.

Respectfully submitted,

SPECIAL COMMITTEE ON STANDARDIZATION,

J. C. IRWIN, *Chairman.*

American Standards Approved by the American Standards Association Period Sept. 1, 1929, to Sept. 1, 1930

A.S.A. Symbol	*Title*	*Approved by*
A 5 —1930	Toughness of Rock, Method of Test for	American Standard
A 9 —1929	Building Exits Code	Amer. Tent. Std.
A11 —1930	Lighting: Factories, Mills and Other Work Places, Code of	American Standard
A26 —1930	Stone, Slag, Gravel, Sand and Stone Block, for Use as Highway Materials, Method of Sampling	American Standard
A37a—1930	Penetration of Bituminous Materials, Standard Method of Test for	American Standard
A37b—1930	Bituminous Materials, Standard Method of Float Test for	American Standard
A37c—1930	Determination of Bitumen, Standard Method of Test for the	American Standard
A43 —1930	Putty, Specifications for	Amer. Tent. Std.
B 3a—1930	Annular Ball Bearings	American Standard
B 3b—1930	Annular Ball and Roll Bearings, Wide Type	Amer. Rec. Prac.
B 5c—1930	Milling Cutters: Nomenclature of; Plain, Side, Angular, Stagger Tooth, End Mills, Metal Slitting, T Slot and Half Slide Cutters; Involute Gear, Stocking, Fluting Reamers and Taps, Concave, Convex, Corner Roundings and Sprocket Cutters; Keys and Key-Ways for Milling Cutters and Arbors	American Standard
B 7 —1930	Abrasive Wheels, Safety Code for the Use, Care and Protection of	American Standard
B18c—1930	Slotted Head Machine Screws and Wood Screw Heads	American Standard
B29a—1930	Roller Chains	American Standard
K13 —1930	Identification of Gas Mask Canisters, Code for the Uniformity in Color Markings for Gas Mask Canisters	Amer. Rec. Prac.
K14 —1930	Liquid Soap, Specifications for	Amer. Tent. Std.
K16 —1930	Dry Red Lead, Methods of Routine Analysis of	American Standard
K18 —1929	Coal and Coke, Method of Laboratory Sampling and Analysis	American Standards
L 1 —1929	Textiles, Safety Code for	Amer. Tent. Std.
M14 —1930	Explosives in Bituminous Coal Mines, Recommended Practice for the Use of	Amer. Rec. Prac.
O 1 —1930	Woodworking Plants, Safety Code for	American Standard
Z10d—1930	Photometry and Illumination, Symbols for	American Standard
Z10e—1930	Aeronautical Symbols	Amer. Tent. Std.
Z10h—1930	Navigational and Topographical Symbols	Amer. Tent. Std.
Z11t—1930	Saponification, Method of Test for	American Standard
Z10u—1930	Detection of Free Sulfur and Corrosive Sulfur Compounds in Gasoline, Method of Test for	American Standard
Z12b—1930	Pulverizing Systems for Sugar and Cocoa	American Standard

American Standards Association Technical Projects on Which the Railway Associations Are Now Co-operating

A 1—1928	Portland Cement, Specifications for
A 3	Steel Bridges
A 4	Structural Steel Shapes, Specifications for
A21	Cast Iron Pipe and Special Castings, Specifications for
A22	Walkway Surfaces, Safety Code for
A25	Bridges, Movable Railway, Specifications for
A35	Manhole Frames and Covers
A36	Rating of Rivers, Methods of
B16	Pipe Flanges and Fittings
B18	Bolt, Nut and Rivet Proportions
B20	Conveyors and Conveying Machinery, Safety Code for
B30	Cranes, Derricks and Hoists, Safety Code for
B32	Wire and Sheet Metal Gages
*B33	Screw Threads for Hose Couplings (Other Than Fire Hose Couplings)
B36	Dimensions and Material of Wrought Iron and Wrought Steel Pipe and Tubing, Standardization of
*B41	Stock Sizes, Shapes and Lengths for Iron and Steel Bars, Including Flats, Squares, Rounds and Other Shapes
*B43	Machine Pins, Dimensions of
*C 1—1930	Electric Wiring and Apparatus in Relation to Fire Hazard, Regulations for (National Electrical Code)
C 2—1927	National Electrical Safety Code
C 5—1929	Lightning, Code for Protection Against
C 8	Wires and Cables, Insulated (Other Than Tele. and Tel.)
C10—1924	Electrical Equipment of Buildings, Symbols for
C11—1927	Hard Drawn Aluminum Conductors, Electrical Constants
C16	Radio
C18—1928	Dry Cells and Batteries, Specifications for
C20	Line Insulators for Voltages Not Exceeding 750
C29	Power Line Insulators for Voltages Exceeding 750
*C34	Mercury Arc Rectifiers
*C42	Electrical Terms, Definitions of
*C44	Rolled Threads for Screw Shells of Electric Sockets and Lamp Bases, Specifications for
C50a	Direct-Current Rotating Machines (formerly C23)
C50b	Alternators, Synchronous Motors and Synchronous Machines in General (formerly C24)
C50c	Induction Motors and Induction Machines in General
C50c1—1928	Induction Motors and Induction Machines in General, Rating Provisions for (formerly C25a—1928)
C50d	Fractional Horsepower Motors (formerly C26)
D 5	Street Traffic Signs, Signals and Markings, Code of
E 8	Seven-Inch, 82-lb. Plain Girder Rail and Splice Bar for Use in Paved Streets. Design for
E 9—1926	Seven-Inch, 92-lb. Plain Girder Rail and Splice Bars for Use in Paved Streets, Design for
E10—1929	Materials for Use in the Manufacture of Special Track Work, Specifications for
E11—1926	Seven-Inch 102-lb. Plain Girder Rail and Splice Bars for Use in Paved Streets, Design for
G 8	Zinc Coating of Iron and Steel, Specifications for
O 3—1926	Cross Ties and Switch Ties, Specifications for
O 4	Wood, Methods of Testing
O 5	Wood Poles, Specifications for
X 2—1922	Protection of the Heads and Eyes of Industrial Workers, Safety Code for.
Z 4	Industrial Sanitation, Safety Code for
Z 5	Ventilation Code
Z10	Scientific and Engineering Symbols and Abbreviations
Z11	Petroleum Products and Lubricants, Methods of Testing
Z14	Drawings and Drafting Room Practice
Z15	Graphics, Standards for

REPORT OF COMMITTEE XV—IRON AND STEEL STRUCTURES

A. R. Wilson, *Chairman;*
P. S. Baker,
J. E. Bernhardt,
A. W. Carpenter,
O. F. Dalstrom,
R. P. Davis,
F. O. Dufour,
Thos. Earle,
S. Hardesty,
C. S. Heritage,
O. E. Hovey,
J. B. Hunley,
M. S. Ketchum,
W. S. Lacher,
B. R. Leffler,
H. S. Loeffler,
C. H. Mercer,
P. B. Motley,
Albert Reichmann,

G. A. Haggander, *Vice-Chairman;*
H. N. Rodenbaugh,
J. M. Salmon,
O. E. Selby,
I. L. Simmons,
W. A. Slater,
C. E. Sloan,
P. B. Spencer,
S. M. Smith,
H. B. Stuart,
R. M. Stubbs,
G. H. Tinker,
G. H. Trout,
F. E. Turneaure,
F. P. Turner,
R. A. VanNess,
H. T. Welty,
W. M. Wilson,

Committee.

To the American Railway Engineering Association:

Your Committee respectfully presents herewith report covering the following subjects:

(1) Revision of Manual (Appendix A).

(2) Track anchorage over bridges and similar structures (Appendix B).

(7) Use of copper-bearing steel for structural purposes (Appendix C).

(10) Specifications for punched and reamed work (Appendix D).

(11) Longitudinal forces as they apply to railway bridge superstructures and sub-structures (Appendix E).

(12) Design for rivet heads for steel structures (Appendix F).

Action Recommended

(1) That the changes in the Manual in Appendix A be approved and the revisions substituted for the present recommendations in the Manual.

(2) That the report on track anchorage over bridges and similar structures (Appendix B) be received as information.

(7) That the report on use of copper-bearing steel for structural purposes (Appendix C) be received as information.

(10) That the report on the specifications for punched and reamed work (Appendix D) be approved and the revision substituted for the present recommendations in the Manual.

(11) That the report on longitudinal forces as they apply to railway bridge superstructures and sub-structures (Appendix E) be received as information.

(12) That the report on design for rivet heads for steel structures (Appendix F) be received as information.

Respectfully submitted,

The Committee on Iron and Steel Structures,

A. R. Wilson, *Chairman.*

Bulletin 330, October, 1930.

Appendix A

(1) REVISION OF MANUAL

I. L. Simmons, Chairman, Sub-Committee; J. E. Bernhardt, O. F. Dalstrom, B. R. Leffler, P. B. Motley, O. E. Selby.

This Committee makes the following report and recommend that it be approved and the revisions substituted for the present recommendations in the Manual:

That Article 1518, Specifications for Steel Highway Bridges, page 1221, of 1929 Manual, the definition of "p" be changed to read, "Allowable unit stress for the column in question."

That Specifications for Steel Railway Bridges, appearing in the 1929 Manual be revised as follows:

Paragraph 8, page 1073, be changed to read:

"Structures shall be made wholly of structural steel except where otherwise specified. Rivet steel shall be used for rivets only. Forged steel shall be used for large pins, large expansion rollers and other parts if specified by the Engineer. Cast steel preferably shall be used for shoes and bearings. Cast iron may be used only where specifically authorized by the Engineer."

Page 1091, Article XI, "Materials," be revised to include Specifications for Forged Steel.

and that the order of the subjects be as follows:

(a) Structural and Rivet Steel.
(b) Forged Steel.
(c) Cast Steel.
(d) Cast Iron.

(b) Forged Steel

Process

182. The steel shall be made by either or both of the following processes: open-hearth or electric-furnace.

Prolongation for Tests

183. Unless otherwise specified, for test purposes at least 20 per cent of the forgings shall be provided with prolongations or, at the manufacturers' option and expense, a forging may be selected.

Heat Treatment

184. Forging shall be annealed. The procedure to be followed in annealing shall consist in allowing the objects, immediately after forging, to cool to a temperature below the critical range, under suitable conditions to prevent injury by too rapid cooling. They shall then be uniformly reheated to the proper temperature to refine the grain (a group thus reheated being known as an "annealing charge"), and allowed to cool uniformly.

Chemical Composition

185. The steel shall conform to the following requirements as to chemical composition:

Manganese, per cent	0.40–0.80
Phosphorus, per cent:	
Acid	Not over 0.05
Basic	Not over 0.05
Sulphur, per cent	Not over 0.05

Ladle Analyses

186. An analysis of each melt of steel shall be made by the manufacturer to determine the percentages of carbon, manganese, phosphorus and sulphur. This analysis shall be made from a test ingot taken during the pouring of the melt. The chemical composition thus determined shall be reported to the Engineer, and shall conform to the requirements specified in Section 185.

Check Analyses

187. An analysis may be made by the Engineer from a forging representing each melt. The chemical composition thus determined shall conform to the requirements specified in Section 185. Drillings for analysis may be taken from the forging or from a full-size prolongation of the same, at any point midway between the center and surface of solid forgings, and at any point midway between the inner and outer surfaces of the wall of bored forgings; or turnings may be taken from a test specimen.

Physical Properties

188. (a) The forgings shall conform to the following requirements as to physical properties:

Tensile Strength, lb. per sq. in. min.	
Not over 12 in. diam	60,000
Over 12 in. to 20 in. diam, incl	60,000
Yield Point, minimum lb. per sq. in.:	
Not over 12 in. diam	0.5 tens. str.
Over 12 in. to 20 in. diam., incl	0.5 tens. str.
Elongation in 2 in. minimum per cent:	
Not over 12 in. diam	$\frac{1{,}700{,}000}{\text{Tens. Str.}}$ Not under 25
Over 12 in. to 20 in. diam., incl	$\frac{1{,}600{,}000}{\text{Tens. Str.}}$ Not under 24
Reduction of area, min. per cent:	
Not over 12 in. diam	$\frac{2{,}700{,}000}{\text{Tens. Str.}}$ Not under 38
Over 12 in. to 20 in. diam., incl	$\frac{2{,}520{,}000}{\text{Tens. Str.}}$ Not under 36

(b) The classification by size of the forging shall be determined by the specified diameter or thickness which governs the size of the prolongation from which the test specimen is taken.

(c) The yield point shall be determined by the drop of the beam of the testing machine.

(d) Tests of forgings shall be made only after final treatment.

Tension Test Specimens

189. (a) Tension test specimens shall be taken from a full-size prolongation of any forging. For forgings with large ends or collars the prolongation may be of the same cross-section as that of the forging back of the large end or collar. Specimens may be taken from the forging itself with a hollow drill, if approved by the Engineer.

(b) The axis of the specimen shall be located at any point midway between the center and surface of solid forgings, and at any point midway between the inner and outer surfaces of the wall of bored forgings, and shall be parallel to the axis of the forging in the direction in which the metal is most drawn out.

(c) The specimens shall conform to the dimensions shown in Fig. 5, Section 172. The ends shall be of the form to fit the holders of the testing machine in such a way that the load shall be axial.

Number of Tests

190. Tests shall be made as follows:

(a) One tension test shall be made from each annealing charge. If more than one melt is represented in an annealing charge one tension test shall be made from each melt.

(b) If any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted.

(c) If the percentage of elongation of any test specimen is less than that specified in Section 188 (a) and any part of the fracture is more than ¾ in. from the center of the gage length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

Retests

191. If the result of the physical tests of any test lot of forgings do not conform to the requirements specified, the manufacturer may retreat such lot one or more times and retests shall be made as specified in Section 190.

Finish

192. The finished material shall be free from injurious defects and shall have a workmanlike finish.

Identification Marks

193. The name or brand of the manufacturer and the melt number shall be legibly stamped or rolled on the finished material, except that rivet and lattice bars and other small sections shall, when loaded for shipment, be separated and marked for identification. The identification marks shall be legibly stamped on the end of each pin and roller. The melt number shall be legibly marked by stamping if practicable, on each test specimen.

Inspection

194. The Inspector representing the Company shall have free entry, at all times while work on the contract of the Company is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the Inspector free of cost all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. Inspections and tests (except check analyses) shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not as interfere unnecessarily with the operation of the works.

Rejection

195. Unless otherwise agreed, any rejection based on analysis made in accordance with Section 187 shall be reported within five working days from receipt of samples.

Material which shows any injurious defect subsequent to its acceptance at the manufacturer's works will be rejected, and the manufacturer shall be notified.

Specimens analyzed in accordance with Section 187, which represent rejected material, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the result of the tests, the manufacturer may make claim for a rehearing within that time.

Appendix B

(2) TRACK ANCHORAGE OVER BRIDGES AND SIMILAR STRUCTURES

W. S. Lacher, Chairman, Sub-Committee; R. P. Davis, S. Hardesty, J. B. Hunley, M. S. Ketchum, G. A. Haggander, B. R. Leffler, P. B. Motley, C. E. Sloan, G. H. Trout, R. A. Van Ness, H. S. Loeffler, J. M. Salmon.

This Committee makes the following report and recommends that it be received as information.

Anchoring track on bridges, as used in the instructions to the Committee, is assumed to mean the securing of the track rails against longitudinal movement relative to the bridge on which they are supported. As the anchoring of rails in ballasted track on a bridge introduces no problem not encountered in track on roadway, the Committee has limited its consideration of the subject to tracks on unballasted structures.

That rails do move relative to the bridge floors on which they are supported is common knowledge, but there are wide variations in experience as to the intensity and prevalence of such movement and corresponding variance in opinion as to the need for measures to prevent it. In answer to a questionnaire addressed to bridge engineers of railways in the United States and Canada, to which 47 replies were received (representing an aggregate of 212,550 main-line miles), 23 stated that the anchorage of track was a problem worthy of study, although 11 considered it of importance only under certain circumstances; 11 others considered anchorage of rails to bridges unnecessary and 12 others did not answer the question directly. Of those who deem anchoring on bridges unnecessary, the majority report that the anchorage of the track on the approach embankments has proved thoroughly effective in preventing movement of rails on bridges. On the whole, however, there is common agreement that the creeping of rail on bridges should be stopped if it is practicable to do so without introducing conditions of a more objectionable nature. In bridges embracing movable spans, it is obvious, of course, that the position of the rails at the rail locks must be fixed; and suitable means to hold the rails in place are always employed. It is a fact, however, that this is being accomplished in some cases by holding only short sections of rail on the fixed spans adjacent to the movable span, allowing the rail on the remaining portions of the fixed structure to run through switch points provided for this purpose.

A clearer insight on that attitude toward the practice of anchoring track on bridges is afforded on the following resumé of prevailing practice obtained from replies to the questionnaire.

Do not anchor on bridges at all, or only bridges with movable spans	21
Find it unnecessary to use anchors because bridges on road are short	2
Anchor on all or most bridges	8
Anchor on longer bridges or spans	9
Anchor on bridges "where necessary"	7
	47

Replies to the question raised as to difficulties encountered by reason of the use of anchors are summarized below.

No trouble	13
Distorted the track	1
Distorted trestles	4
Bunched and split the ties	4
Bunched and split the ties in cases where slot-spiking served as the anchorage	1
No trouble where the anchorage provided on both the bridge and the approach banks is adequate	3
No reply	21
	47

It is clear from this summary that efforts to anchor the rails to the bridge deck have not always been attended with satisfactory results. This is not surprising because such efforts have been made without the benefit of even approximate data as to the forces to be resisted. That these forces are of considerable magnitude is well known to every trackman, and three of the replies to the questionnaire report cases where trestles on which the rails had been anchored were moved in a longitudinal direction to an extent that resulted in decided leaning of the bents. In two cases, the conditions reported were so severe as to require additional longitudinal bracing. Five replies report distortion of the track or injury to some portions of the deck, primarily the ties.

In contrast with these experiences is the fact that 13 roads report no trouble that may be ascribed to the practice of anchoring and that three experienced no trouble in cases where the anchorage provided on both the bridge and approach embankments was "adequate." For example, the experience of the Southern, which recently adopted the practice of anchoring the rails on bridges, is reported by J. B. Akers, Assistant to Vice-President, as follows: "We had theories as to what would happen, but since anchoring track on bridges where creeping had occurred, found better conditions than ever before."

No General Rule Can Be Given

The design of a structure subjected to forces incapable of accurate or even approximate determination must necessarily proceed along empirical lines. It is necessary to rely on experience in the proportioning of the parts. Therefore, in dealing with the running of rails on bridges, it is necessary to follow the same practice that has prevailed in the anchoring of track on roadbed, namely, to apply as many anti-creeping devices of suitable design as are found necessary under individual circumstances. Experience on a considerable number of roads indicates that thorough anchorage of the track on approach embankments makes it unnecessary to provide means of securing the rails against movement on bridges of moderate length. It follows, therefore, that it would be questionable practice to attempt to hold the rails against movement on a bridge without insuring that anchorage on the approaches was thoroughly effective. This point is clearly brought out in the statement by W. H. Kirkbride, Chief Engineer Maintenance of Way, Southern Pacific, Pacific System:

"There is no objection to anchoring track on bridges or trestles if the track adjacent to the structure is anchored sufficiently to bear its proper resistance to the rail movement. The objection to this practice becomes apparent when the bridge bears more than its proportion of this resistance through the absence of sufficient anchorage on the approach embankments."

Controlling the creeping of rails on open-deck bridges imposes three requirements—means of holding the rails against longitudinal movement relative to the ties, means of preventing the movement of the ties on the stringers or girders and the satisfactory solution of certain problems of anrchorage imposed by reason of change in length of bridge spans under varying conditions of load and temperature. Except in the case of the breaks in rails at the ends of movable spans, it appears that means are rarely provided for anchoring the rails direct to the steelwork.

Of those roads that anchor the rails on bridges, 19 employ commercial anti-creepers to transmit the longitudinal force from the rails to the ties; six employ special construction; while four roads report the use of both commercial anti-creepers and anchors of special design.

Methods of Anchoring

As practice with respect to the number of anchors used varies with the requirements as determined by local experience, no general statement as to the number used is possible. However, information was obtained from 18 railways as to the general rules observed in applying anchors. The data are summarized in the table supplemented by several sketches.

The anchors are applied as in track on roadbed, taking into account the prevailing direction of the creeping or, in some cases on single-track bridges, to resist movement in either direction. The location of the anchors is influenced largely by the means provided for anchoring the ties to the structure. As the most common practice is to secure the third, fourth or even the sixth tie to the stringer by hook bolts, the tie so fastened is selected for the application of the rail anchors. Three roads report the use of small angles riveted to the top flange of the stringer with its vertical leg bearing against the tie or the side opposite to that against which the anchors bear. In two cases dependence is placed, on deck girders, on the resistance afforded by rivet heads allowed to crush into the ties or bearing against the sides of slots cut into the ties. On one railway the anchors are placed on the ties in through bridges that are in contact with floor beams.

In outlining practice with respect to the distribution of the anchors, most of the data obtained imply a more or less uniform distribution expressed in such terms as "four to six per rail," "approximately 10-ft. centers," "on ties adjacent to floor beams," etc. In only three replies to the questionnaire is specific reference made to any consideration of the location of expansion bearings of bridge spans in relation to the placing of the anchors. On three roads, namely, the Chicago, Burlington & Quincy, the Baltimore & Ohio and the Northern Pacific, it is the practice to concentrate the anchors on several ties near the fixed ends of spans. It is possible that other roads, concerning which the Committee has no information, observe this same rule. In the opinion of the Committee failure to take into account, in this or some other way, the changes in the width of the gap between spans over expansion

bearings must surely lead to damage to the ties to which anchors are applied or the slipping of the anchors. It is possible that some of the difficulties experienced in the use of rail anchors on bridges may have resulted from this cause.

Conclusions

(1) As the magnitude of the forces causing rails to creep is unknown, the anchoring of rails on bridges may impose longitudinal forces to the structure for which adequate provision has not been made in the design.

(2) The creeping of rails in the tracks approaching the bridge must be controlled on the approaches.

(3) In cases where the effect of traffic on the track on the bridge results in creeping of rails to such an extent as to render it difficult to maintain a uniform distribution of the expansion allowance at the rail joints on the bridge or prove otherwise objectionable, anchorage may be provided on the bridge, provided the track on the approaches is effectively anchored.

(4) If under the conditions outlined in paragraph 3, it is deemed advisable to allow the rails on the bridge to run, switch points or suitable slip joints must be provided on the embankment at both ends of the structure.

Appendix C

(7) COPPER-BEARING STEEL FOR STRUCTURAL PURPOSES

F. P. Turner, Chairman, Sub-Committee; P. S. Baker, A. W. Carpenter, Thos. Earle, W. S. Lacher, C. H. Mercer, C. E. Sloan, G. H. Trout, H. S. Loeffler, R. A. VanNess.

This Committee makes the following report and recommends that it be received as information:

The report of this Sub-Committee, as shown upon page 1015 of A.R.E.A. Bulletin 314, February, 1929, contains the most conclusive information found on record, in which the value of copper-bearing steel has actually been determined from service tests, in that part of the report referring to its use and service in the manufacture of tie plates and in the manufacture of freight cars. Reference is also made to information on this subject, as printed in A.R.E.A. Bulletin 322, December, 1929, pages 974 and 975.

Information recently collected from four large manufacturers indicates an increased use of copper-bearing steel for structural purposes, and the tonnage manufactured during the year 1929 was more than 50 per cent greater than that manufactured during the year 1928. Reports received show that four of our largest railroad systems are now specifying copper-bearing steel for railway bridges, and there is also an increase in the use of this material for turntables, and for roof and side panels on steel buildings.

During the past year one of our largest eastern cities has purchased copper-bearing structural steel for a bascule highway bridge and approaches.

Appendix D

(10) PUNCHED AND REAMED WORK

F. O. Dufour, Chairman, Sub-Committee; Thos. Earle, G. A. Haggander, H. S. Loeffler, Albert Reichmann, O. E. Selby, W. A. Slater, H. B. Stuart, G. H. Tinker, F. P. Turner.

At the Convention held March, 1928, this Committee recommended: That Article XII, Workmanship, in General Specifications for Steel Railway Bridges, as issued August, 1925, Third Edition, be revised and received as information (see Appendix A—Report of Committee on Iron and Steel Structures—Proceedings Vol. 29, page 367).

At the Convention held March, 1929, this Committee furnished data and the results of a series of experiments (see Appendix F—Report of Committee on Iron and Steel Structures—Proceedings Vol. 30, page 1078) covering punched and reamed work.

This Committee makes the following report and recommends that it be approved and the revisions substituted for the present recommendations in the Manual.

GENERAL SPECIFICATIONS FOR STEEL RAILWAY BRIDGES

For Fixed Spans Less Than 300 Feet in Length

(XII) WORKMANSHIP

General

206. The workmanship and finish shall be equal to the best general practice in modern bridge shops. Material at the shops shall be kept clean and protected from the weather as far as practicable.

Straightening Material

207. Rolled material, before being laid off or worked, must be straight. If straightening or flattening is necessary, it shall be done by methods that will not injure the material. Sharp kinks and bends may be cause for rejection.

Finish

208. Shearing and chipping shall be neatly and accurately done and all portions of the work exposed to view shall be neatly finished.

Punching and Reaming

209. All main material, forming parts of a member composed of not more than 3 thicknesses of metal, may be punched with a punch $\frac{1}{16}$ in. larger than the nominal size of the rivets, whenever the thickness of the metal is not greater than $\frac{5}{8}$ in. When there are more than 3 thicknesses of main material, or when any of the main material is thicker than $\frac{5}{8}$ in., all of the holes shall be punched with a punch $\frac{3}{16}$ in. smaller, and after assembling reamed $\frac{1}{16}$ in. larger than the nominal size of the rivets, except that when the metal is thicker than the size of the rivet minus $\frac{1}{8}$ in., the holes shall be drilled.

210. Material $\frac{7}{8}$ in. or less, in thickness used for lateral, longitudinal and sway bracing, lacing, stay plates and diaphragms, may be punched with a punch $\frac{1}{16}$ in. larger than the nominal size of the rivet.

211. The diameter of the die shall not exceed the diameter of the punch by more than $\frac{3}{32}$ in. If any holes must be enlarged to admit the rivets, they shall be reamed. Holes must be clean cut, without torn or ragged edges. Poor matching of holes may be cause for rejection.

Reaming After Assembling

212. Reaming shall be done after the pieces forming a built member are assembled and so firmly bolted together that the surfaces are in close contact. Burrs on the outside surface shall be removed. The pieces shall be taken apart before riveting, if necessary, and any shavings removed. When it is necessary to take the members apart for shipping or handling, the pieces reamed together shall be so marked that they may be reassembled in the same position in the final setting up. No interchange of reamed parts will be permitted.

213. The holes shall be cylindrical, perpendicular to the member, and not more than $\frac{1}{16}$ in. larger than the nominal size of the rivets. Reamers preferably shall not be directed by hand.

Drilled Holes

214. Drilled holes shall be $\frac{1}{16}$ in. larger than the nominal size of the rivet. Burrs on the outside surfaces shall be removed. Drilling shall be accurately done and poor matching of holes may be cause for rejection.

Reaming and Drilling

215. Reaming and drilling shall be done with twist drills.

Shop Assembling

216. The parts of riveted members shall be well pinned and firmly drawn together with bolts before riveting is commenced. The drifting done during assembling shall be only such as to bring the parts into position and not sufficient to enlarge the holes or distort the metal.

Field Connections

217. Solid floor sections shall be assembled to the girders or trusses, or to suitable frames, in the shop, and the end connections made to fit.

218. Riveted trusses shall be assembled, either in whole or in part, in the shop to line and fit and the holes for field connections drilled or reamed while so assembled; or else these connections shall be reamed to proper metal templates so placed as to result in fair holes for the connections. Holes for other field connections, except those in lateral, longitudinal and sway bracing, shall be reamed or drilled to a metal template.

Match-Marking

219. Connecting parts assembled in the shop for the purpose of reaming or drilling holes in field connections shall be match-marked, and a diagram showing such marks shall be furnished the Engineer.

Rivets

220. Rivets before heating shall be of the size called for on the plans.

221. Rivet heads shall be of approved shape and of uniform size, for the same diameter of rivet. They shall be full, neatly made, concentric with the rivet holes, and in full contact with the surface of the member.

Riveting

222. Rivets shall be heated uniformly to a light cherry red and driven while hot. They shall be free from slag, scale, and carbon deposit. When driven, they shall completely fill the holes. Loose, burned, or otherwise defective rivets shall be replaced. In removing rivets, care shall be taken not to injure the adjacent metal and, if necessary, they shall be drilled out. Caulking or recupping will not be permitted.

223. Rivets shall be driven by direct-acting riveters where practicable. The riveters shall retain the pressure after the upsetting is completed.

224. When rivets are driven with a pneumatic riveting hammer, a pneumatic bucker shall be used for holding up, when practicable.

Field Rivets

225. Field rivets shall be furnished in excess of the nominal number required to the amount of 15 per cent, plus ten rivets, for each size and length.

226. Field rivets shall be free from fins on the under side of the head.

Turned Bolts

227. Where turned bolts are used to transmit shear, the holes shall be reamed parallel and the bolts shall make a tight fit with the threads entirely outside of the holes. A washer not less than ¼ in. thick shall be used under each nut. Turned bolts shall have the thread $\frac{1}{16}$ in. less in diameter than the body of the bolt and the bolt shall be $\frac{1}{32}$ in. less than the diameter of the hole.

Planing Sheared Edges

228. Sheared edges of main material more than ⅝ in. thick shall be planed to a depth of ¼ in. Reentrant cuts shall be filleted before cutting.

Flame cutting of main material will not be permitted unless approved by the Engineer.

Lacing Bars

229. The ends of lacing bars shall be neatly rounded, unless otherwise called for.

Fit of Stiffeners

230. Stiffeners under the top flanges of deck girders and at all bearing points shall be milled or ground to bear against the flange angles. Other stiffeners must fit sufficiently tight against the flange angles to exclude water after being painted. Fillers and splice plates shall fit within ¼ in. at each end.

Web Plates

231. Web plates of girders which have no cover plates may be ⅛ in. above or below the backs of the top flange angles. Web plates of girders which have cover plates may be ½ in. less in width than the distance back to back of flange angles.

232. When web plates are spliced, not more than ⅜ in. clearance between ends of plates will be allowed.

Facing Floor Beams, Stringers and Girders

233. Floor beams, stringers and girders having end connection angles shall be made of exact length. If facing is necessary, the thickness of the end connection angles shall not be reduced more than ⅛ in. at any point.

Webs shall be within ⅛ in. of back of end connection angles.

Finished Members

234. Finished members shall be true to line and free from twists, bends and open joints.

Abutting Joints

235. Joints and splices in compression members and girder flanges, and in tension members where so specified on the drawings, shall have the abutting surfaces faced and brought to an even bearing. Where joints are not faced, the opening shall not exceed ¼ in.

Eye-Bars

236. Eye-bars shall be straight, true to size, and free from twists, folds in the neck or head, and other defects. The heads shall be made by upsetting, and rolling or forging. Welding will not be allowed. The thickness of the head and neck shall not overrun more than $\frac{1}{16}$ in. for bars 8 in. or less in width, $\frac{1}{8}$ in. for bars more than 8 in. and not more than 12 in. in width, and $\frac{3}{16}$ in. for bars more than 12 in. in width.

237. Eye-bars which are to be placed side by side in the structure shall be bored so accurately that, upon being placed together, the pins will pass through the holes at both ends at the same time without driving. Eye-bars shall have both ends bored at the same time.

Annealing

238. Eye-bars shall be annealed by heating uniformly to the proper temperature followed by slow and uniform cooling. Proper instruments shall be provided for determining at all times the temperature of the bars.

239. Other steel which has been partially heated shall be annealed except where used in minor parts.

Boring Pin Holes

240. Pin holes shall be bored true to gage, smooth, straight at right angles with the axis of the member and parallel with each other, unless otherwise required. The variation from the specified distance from outside to outside of pin holes in tension members, or from inside to inside of pin holes in compression members, shall not exceed $\frac{1}{32}$ in. for each 75 ft. or fraction thereof in length. In built-up members the boring shall be done after the member is riveted.

Boring Pins

241. Pins more than 9 in. in diameter shall have a hole bored longitudinally through the center of each not less than 2 in. in diameter.

Pin Clearances

242. The difference in diameter between the pin and the pin hole shall be $\frac{1}{50}$ in. for pins up to 5 in. in diameter, and $\frac{1}{32}$ in. for larger pins.

Pins and Rollers

243. Pins and rollers shall be accurately turned to gage and shall be straight, smooth and free from flaws.

Screw Threads

244. Screw threads shall make close fits in the nuts and shall be U.S. Standard, except that for pin ends of diameters greater than $1\frac{3}{8}$ in. they shall be made with six threads to an inch.

Forging Pins

245. Pins more than 7 in. in diameter shall be forged and annealed.

Bearing Surfaces Planed

246. The top and bottom surfaces of base and cap plates of columns and pedestals shall be planed, or else hot-straightened and parts of members in contact with them shall be faced to fit. Connection angles for base plates and cap plates shall be riveted to compression members before the members are faced.

247. Sole plates of plate girders shall have full contact with the girder flanges. Sole plates and masonry plates shall be planed or hot-straightened. Cast pedestals shall be planed on the surfaces in contact with steel and on surfaces resting on masonry.

Pilot Nuts

248. Two pilot nuts and two driving nuts shall be furnished for each size of pin, unless otherwise specified.

Appendix E

(11) LONGITUDINAL FORCES AS THEY APPLY TO RAILWAY BRIDGE SUPERSTRUCTURES AND SUBSTRUCTURES

W. S. Lacher, Chairman, Sub-Committee; G. A. Haggander, R. P. Davis, Shortridge Hardesty, J. B. Hunley, M. S. Ketchum, B. R. Leffler, P. B. Motley, C. E. Sloan, G. H. Trout, R. A. VanNess, H. S. Loeffler, J. M. Salmon.

This Committee makes the following report and recommends that it be received as information:

Two sources of longitudinal forces to which bridges are subjected, namely, the application of brakes and the tractive effort of locomotives, were discussed in the report presented by your Committee at the convention in 1930 and which appears on page 997, Vol. 31, of the Proceedings. In that report, the Committee determined upon 25 per cent of the weight on locomotive driving wheels as the value to be used in taking account of the tractive effort.

The report also reviewed current practice in the proportioning of air brake apparatus on various classes of equipment, and explained the method of determining the retarding force that is applied to the rails by the wheels of cars and locomotives under full-service brake applications. This method has been applied to various classes of equipment for the purpose of determining how the retarding force in each case compares with the loaded weight of the equipment, that is, weight in working order for locomotives and weight under "load limit" lading in the case of freight cars.

These calculations show that in locomotives the retarding force is equal to about 13 per cent of the weight in working order. In freight train cars it is less than four per cent of the weight under full load, except in the case of refrigerator cars, but even with these the retarding force is less than four per cent of Cooper's E50 loading.

The retarding force exerted by the brakes of a standard Pullman sleeping car, as demonstrated in the report cited above, is equal to 325 lb. per ft. of track and is equivalent to the following percentages of the trailing load for different loadings.

Loading	*Retarding Force Produced by a Pullman Sleeper in Per Cent of Trailing Live Load.*
E50	6.5 per cent
E60	5.4 per cent
E70	4.6 per cent
E80	4.1 per cent
E90	3.6 per cent

It will be observed that the Pullman sleeper or passenger train car of equivalent weight produces a greater retarding force than any freight train cars except those heavier than the equivalent of E80 loading.

Wind

The effect of a tail wind or one having an appreciable longitudinal component is another factor to be taken into account. Structural engineers deal with wind loads as pressures normal to the surface, but in dealing with a head wind or a tail wind acting on a train, skin friction or viscosity resistance becomes a factor. This has been the subject of research in connection with the problem of aeronautics, but with masses and areas of such proportions that the results obtained cannot be applied to railway trains with much confidence.

The converse of the problem—the effect of air resistance as a factor of speed resistance was the subject of experiments on small models by Solberg at Purdue University in 1895-96, reported in Goss' Locomotive Performance (1906). These studies gave rise to empirical formulas and tables of resistances for various speeds and lengths of trains. According to these, the air resistance at 100 m.p.h. ranges from 13.4 lb. per ft. of train for a train 100 ft. long to 4.04 lb. for a train 1000 ft. long.

These values compare favorably with those obtained by the application of formulas developed in aeronautical research, but it is generally agreed that the effect of wind or air resistance on trains cannot be accurately determined without further research. However, it is clear that the effect of wind is small as compared with the other sources of longitudinal force and is of importance only as an added factor to be considered as acting simultaneously with brake applications or tractive effort. Therefore, we are concerned only with such wind velocities as would be reasonably expected under normal train operation. Their effect, therefore, falls within the limits of established values for train resistance at high speeds.

Conclusion

In view of these considerations the Committee feels that the following clause covering the longitudinal force to be used in bridge design meets conditions now actually imposed and makes a reasonable allowance for possible future increases in the power of brake equipment.

Longitudinal Forces

(A) Forces due to braking—15 per cent of the weight of locomotives and tenders plus 5 per cent of the weight of the train load, but not less than 350 lb. per ft. of track, or

(B) Forces due to traction—25 per cent of the weight on driving wheels of locomotives.

Appendix F

(12) DESIGN OF RIVET HEADS FOR STEEL STRUCTURES

G. H. Tinker, Chairman, Sub-Committee; R. P. Davis, C. S. Heritage, C. H. Mercer, Albert Reichmann, C. E. Sloan, J. M. Salmon, R. M. Stubbs, H. T. Welty.

This Committee makes the following report and recommends that it be received as information:

Function of Rivet Head

Rivets are ordinarily designed for shear and bearing. Some experiments indicate that a riveted joint functions by friction between the parts. Whether or not this is true, it is essential that the parts be held in close contact. It is customary to assume that the shrinkage of rivets in cooling causes the heads to grip the parts tightly. In some cases the design is such that the rivet is in tension. Therefore, it seems that the bearing of the rivet head on the area of the ring surrounding the rivet hole and the shear value on the plane of the cylinder produced by the prolongation of the rivet shank through the head should each be equal to the value of the rivet shank in tension.

Assuming the unit in shear at ¾ the unit in tension and the unit in bearing at 1½ times the unit in tension, the diameter of the rivet head should be 1.3 times the diameter of the shank and the depth of the head on the prolongation of the rivet shank should be ⅓ the rivet diameter in order to produce conditions of equal strength.

The driven heads shown in Table No. 2 have a diameter of 1½ times the diameter of the rivet shank plus ⅛ in. and the depth of head on the prolongation of the shank is from .47 to .67 of the diameter of the rivet shank.

These dimensions are in excess of the theoretical requirements and that they are ample is shown by the fact that rivet heads of this shape do not fail in shear or bearing but the rivet shanks sometimes fail in tension.

Button Head Rivets

The shape of the manufactured head before driving shall be as shown in Table No. 1.

A variation of not more than $\frac{1}{16}$ in. greater or $\frac{1}{32}$ in. less than the nominal diameter of the head and of $\frac{1}{32}$ in. greater than the nominal height of the head will be permitted.

The shape of the driven heads shall be as shown in Table No. 2.

Button head rivets may have a $\frac{1}{16}$ in. fillet under the head but shall be free from fins.

Countersunk Head Rivets

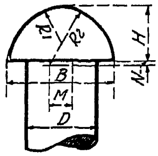
The shape of the manufactured head shall be as shown in Table No. 3. There shall be no fillet between the under-side of the head and the shank. No fins will be permitted.

A variation of not more than $\frac{1}{32}$ in. less than the nominal height of the head will be permitted.

TABLE No. 1—BUTTON HEAD RIVETS
SHAPE OF MFG. HEAD

DIA. OF RIVET	DIA. OF HEAD	HEIGHT OF HEAD	RADII OF HEAD	
D	B	H	R_1	R_2
$\frac{1}{2}$	$\frac{25}{32}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{21}{32}$
$\frac{5}{8}$	$\frac{31}{32}$	$\frac{19}{32}$	$\frac{3}{16}$	$\frac{3}{4}$
$\frac{3}{4}$	$1\frac{5}{32}$	$\frac{11}{16}$	$\frac{9}{32}$	$\frac{27}{32}$
$\frac{7}{8}$	$1\frac{11}{32}$	$\frac{25}{32}$	$\frac{3}{8}$	$\frac{15}{16}$
1	$1\frac{17}{32}$	$\frac{7}{8}$	$\frac{15}{32}$	$1\frac{1}{32}$
$1\frac{1}{8}$	$1\frac{23}{32}$	$\frac{31}{32}$	$\frac{9}{16}$	$1\frac{1}{8}$
$1\frac{1}{4}$	$1\frac{29}{32}$	$1\frac{1}{16}$	$\frac{21}{32}$	$1\frac{7}{32}$
$1\frac{3}{8}$	$2\frac{3}{32}$	$1\frac{5}{32}$	$\frac{3}{4}$	$1\frac{5}{16}$
$1\frac{1}{2}$	$2\frac{9}{32}$	$1\frac{1}{4}$	$\frac{27}{32}$	$1\frac{13}{32}$
$1\frac{5}{8}$	$2\frac{15}{32}$	$1\frac{11}{32}$	$\frac{15}{16}$	$1\frac{1}{2}$
$1\frac{3}{4}$	$2\frac{21}{32}$	$1\frac{7}{16}$	$1\frac{1}{32}$	$1\frac{19}{32}$

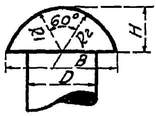
Radius Center Co-ordinates
$M = \frac{1}{2}''$
$N = \frac{3}{32}''$



Formulae
$B = 1.5D + \frac{1}{32}$
$H = .75D + \frac{1}{8}$
$R_1 = .75D - \frac{3}{32}$
$R_2 = .75D + \frac{9}{32}$

TABLE No. 2—BUTTON HEAD RIVETS
SHAPE OF DRIVEN HEAD

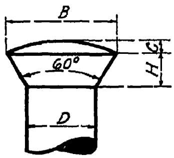
DIA. OF RIVET	DIA. OF HEAD	HEIGHT OF HEAD	RADII OF HEAD	
D	B	H	R_1	R_2
$\frac{1}{2}$	$\frac{7}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{9}{16}$
$\frac{5}{8}$	$1\frac{1}{16}$	$\frac{29}{64}$	$\frac{29}{64}$	$\frac{43}{64}$
$\frac{3}{4}$	$1\frac{1}{4}$	$\frac{17}{32}$	$\frac{17}{32}$	$\frac{51}{64}$
$\frac{7}{8}$	$1\frac{7}{16}$	$\frac{39}{64}$	$\frac{39}{64}$	$\frac{59}{64}$
1	$1\frac{5}{8}$	$\frac{11}{16}$	$\frac{11}{16}$	$1\frac{1}{32}$
$1\frac{1}{8}$	$1\frac{13}{16}$	$\frac{49}{64}$	$\frac{49}{64}$	$1\frac{5}{32}$
$1\frac{1}{4}$	2	$\frac{27}{32}$	$\frac{27}{32}$	$1\frac{9}{32}$
$1\frac{3}{8}$	$2\frac{3}{16}$	$\frac{59}{64}$	$\frac{59}{64}$	$1\frac{3}{8}$
$1\frac{1}{2}$	$2\frac{3}{8}$	1	1	$1\frac{1}{2}$
$1\frac{5}{8}$	$2\frac{9}{16}$	$1\frac{5}{64}$	$1\frac{5}{64}$	$1\frac{5}{8}$
$1\frac{3}{4}$	$2\frac{3}{4}$	$1\frac{5}{32}$	$1\frac{5}{32}$	$1\frac{3}{4}$



Formulae
$B = 1.5D + \frac{1}{8}$
$H = .625D + \frac{1}{16}$
$R_1 = H$
$R_2 = 1.5H$

TABLE No. 3—COUNTERSUNK HEAD RIVETS
SHAPE OF MFG. HEAD

DIA. OF RIVET	DIA. OF HEAD	HEIGHT OF HEAD	HEIGHT OF OVAL
D	B	H	C
$\frac{1}{2}$	.788	.250	.093
$\frac{5}{8}$	.985	.312	.117
$\frac{3}{4}$	1.183	.375	.140
$\frac{7}{8}$	1.380	.437	.164
1	1.577	.500	.187
$1\frac{1}{8}$	1.774	.562	.210
$1\frac{1}{4}$	1.971	.625	.234
$1\frac{3}{8}$	2.168	.687	.257
$1\frac{1}{2}$	2.366	.750	.281
$1\frac{5}{8}$	2.563	.812	.304
$1\frac{3}{4}$	2.760	.875	.328



Formulae
$B = 1.577D$
$H = .5D$
$C = .187D$

REPORT OF COMMITTEE XII—RULES AND ORGANIZATION

E. H. BARNHART, *Chairman;*
J. P. ANDERSON,
F. W. ARMISTEAD,
F. AURYANSEN,
W. E. BAKER,
W. C. BARRETT,
D. P. BEACH,
L. D. BEATTY,
RICHARD BROOKE,
H. L. BROWNE,
C. J. CHASE,
P. D. COONS,
J. L. DOWNS,
A. L. FISHER,

R. E. WARDEN, *Vice-Chairman;*
A. B. GRIGGS,
C. D. HARDING,
F. HIGHLEYMAN,
A. A. JACKSON,
A. R. JONES,
B. R. KULP,
R. D. MARTIN,
R. E. PATTERSON,
R. N. PRIEST,
W. E. SIMPSON,
W. H. WHEATON,
F. B. WIEGAND,

Committee.

To the American Railway Engineering Association:

Your Committee respectfully presents herewith report covering the following subjects:

(1) Revision of Manual, collaborating with appropriate Committees (Appendix A).

(2) Rules for the guidance of employees of the Maintenance of Way Department, with special reference to:

(a) Maintenance of Bridges, collaborating with Committees VII—Wooden Bridges and Trestles, VIII—Masonry, and XV—Iron and Steel Structures (Appendix B).

(b) Maintenance of Structures other than buildings, collaborating with Committees VI—Buildings, XIV—Yards and Terminals, and XXIII—Shops and Locomotive Terminals (Appendix C).

(c) Maintenance of telegraph and telephone lines and appurtenances, collaborating with Telegraph and Telephone Section, A.R.A.

(3) Titles employed to designate positions of corresponding rank in maintenance of way service, subordinate to that of Division Engineer (Appendix D).

(4) Rules for fire prevention as applying to Maintenance of Way Department, collaborating with the Railway Fire Protection Association.

(5) Collaborate with committees of the National Council of State Boards of Engineering Examiners, American Engineering Council, American Society of Civil Engineers, and other national organizations on codification of existing engineering registration laws in the United States and countries contiguous thereto and keep the Association informed of progress of same (Appendix E).

Action Recommended

(1) The Committee offers in Appendix A, for approval and printing in the Manual, additional rules for employees working on or about the track to be known as Rules 212 to 214, inclusive, to be inserted following Rule 211 on page 803 in Manual of 1929.

Bulletin 330, October, 1930.

The Committee also offers in Appendix A, for approval and printing in the Manual, a revision of Rule 952, shown on page 839 of the 1929 Manual, under the heading "Buildings." There are also offered for approval and printing in the Manual three new rules, Nos. 170 to 172, inclusive, to appear in the Manual following Rule 158, page 803, under a new heading: "RULES FOR GOVERNMENT OF EMPLOYEES ENGAGED IN MAINTENANCE OF BUILDINGS AND STRUCTURES." These three new rules and revision of Rule 952 have the approval of Committee VI—Buildings and Committee XV—Iron and Steel Structures.

(2a) The Committee offers for approval and printing in the Manual, Rules 1200 to 1220, inclusive, shown in Appendix B—Rules for Maintenance of Bridges—Wooden Structures. These rules have the approval of Committee VII—Wooden Bridges and Trestles.

(2b) The Committee offers for approval and printing in the Manual, Rules 1250, 1261-1264, 1270-1274, 1280-1287 and 1290-1297, shown in Appendix C, being Rules for Maintenance of Other Terminal Structures—Oil Houses, Coaling Stations, Cinder Pits, Turntables and Track Scales. These rules have the approval of Committees VI—Buildings, XIV—Yards and Terminals, and XXIII—Shops and Locomotive Terminals.

(2c) The Committee has had several conferences with a committee of Telegraph and Telephone Section, A.R.A., extending over a period of several years. Prior to the 1930 Convention the Committee selected a number of general rules from the Manual of the Telegraph and Telephone Section, A. R. A., which it felt were valuable for employees of the Maintenance of Way Department engaged in telegraph and telephone work and requested permission to print these rules in the A.R.E.A. Manual, giving proper recognition to the Telegraph and Telephone Section of the A R.A. This permission was not granted by the Telegraph and Telephone Section of the A.R.A. and the question was referred to the Board of Direction for further instructions. Up to the time of the submission of this report a decision has not been reached.

(3) The Committee offers as information in Appendix D titles of Assistant Engineer and Foremen in the Maintenance of Way Department.

A summary of replies to questonnaire sent to representative railways of the United States and Canada is shown as Appendix D.

While some of the titles are not employed on a number of the railways, they are either employed on a large majority of these replying to the questionnaire, or are more commonly used than equivalent titles of the corresponding rank. A number of these titles have been in general use by this Association in the past.

It is the sense of the Committee that the titles shown on Appendix D are the proper titles to designate positions of corresponding rank in maintenance of way service and to promote uniformity in nomenclature.

(4) Considerable progress has been made by the Committee in connection with this assignment, but on account of the necessity of collaboration with the Railway Fire Protection Association, and the fact that the information was not completed in time for such collaboration, the Committee is not able to submit a report this year.

(5) The Committee presents as information in Appendix E—"A Recommended Uniform Registration Law for Professional Engineers and Land Surveyors." This law was compiled by a committee of representatives of the American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Association of Engineers, New York State Society of Professional Engineers and Land Surveyors, and National Council of State Boards of Engineering Examiners, and has been adopted and endorsed by:

American Society of Civil Engineers, April 21, 1930
American Association of Engineers, April 26, 1930
American Institute of Consulting Engineers, June 4, 1930
Oregon Technical Council, June 18, 1930
Minnesota State Board of Regis. for Architects, Engineers and Land Surveyors, June 23, 1930
Maryland Association of Engineers—June 27, 1930
South Carolina State Board of Engineering Examiners, July 8, 1930
South Carolina Society of Engineers, July 9, 1930
Engineers Club of San Diego, July 10, 1930
Chattanooga Engineers Club, August 23, 1930
Iowa Board of Engineering Examiners, September 5, 1930
Engineers and Architects Club of Louisville—September 5, 1930

It has also been adopted as to form, but subject to necessary amendments applicable to individual states, by the National Council State Boards of Engineering Examiners at its Convention in Richmond, Va., on October 21, 1930.

Respectfully submitted,

THE COMMITTEE ON RULES AND ORGANIZATION,

E. H. BARNHART, *Chairman.*

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Appendix A

(1) REVISION OF MANUAL

P. D. Coons, Chairman, Sub-Committee.

Rules for Employees Working on or About the Track (p. 803)

Present Form	*Proposed Form*
New.	212. Employees must not stand within swing of tools in hands of workmen or in front of rivets or bolts being chiseled off.
New.	213. Brooms, bagging or similar material must be used when cutting off bolt heads, etc.
New.	214. Sledge and not spike mauls must be used to strike cutting and drilling tools.

Buildings (p. 839)

Present Form	*Proposed Form*
952. Small defects, such as broken glass, locks, wood work, etc., must receive prompt attention. Toilet facilities, water and sewer leads must be maintained in good order. Attention must be given to supplying durable hardware for all buildings. (p. 839)	952. Small defects, such as broken glass, locks, wood work, etc., must receive prompt attention. *Broken window glass must be carefully removed by hand and not knocked out.* Toilet facilities, water and sewer leads must be maintained in good order. Attention must be given to supplying durable hardware for all buildings.
New (p. 803).	Heading—Rules for the Government of Employees Engaged in the Maintenance of Buildings and Structures.
New.	170. Employees must stand clear of cable or chain when under strain and must not ride or hang on hook or load which is being hoisted.
New.	171. Employees must secure ladders against slipping before using and making use of a safety rope or belt when working outside of windows or on steep pitched roofs.
New.	172. Brooms, bagging or similar material must be used when cutting off rivets, etc.

Appendix B

(2-A) RULES FOR MAINTENANCE OF BRIDGES—WOODEN STRUCTURES

A. B. Griggs, Chairman, Sub-Committee.

1200. Bridges must be kept in line and surface; bolts and nuts must be kept in proper place and adjustment; bents must be plumb, and stringers have adequate bearing on the caps; braces must be securely fastened.

1201. All brush and rubbish which may tend to increase the fire hazard shall be kept clear of all wooden structures, and the ground scalped under the same. Facilities for extinguishing fires must be kept in good condition and receptacles kept filled.

1202. When ordering treated timber, state exact sizes and lengths desired. Cutting treated timber to length in the field shortens its life and should be done only when unavoidable.

1203. As far as practicable, all gaining, boring, sizing, and surfacing should be done before treatment, and must be so specified when ordering.

1204. When cutting to length is unavoidable or when necessary to adze or otherwise disturb the surface of treated timber, such surfaces must be swabbed with a liberal quantity of hot preservative, followed by two applications of hot sealing compound.

1205. When necessary to bore treated timber in the field, all holes must be treated with hot preservative, followed by sealing compound applied hot, and the bolt immediately driven home.

1206. When unused holes are left in treated timber or piling, they must be treated with hot preservative and filled with treated plugs. Before driving, the plugs must be dipped in hot sealing compound.

1207. Nailing, spiking, and boring of treated timber or piling for support of scaffolding, is prohibited and must not be cut or punctured by bar or pick when inspecting same.

1208. Piling, where cut off, must be treated with hot preservative, following by two coats of hot sealing compound, a sheet of approved material, placed and then another application of sealing compound applied hot.

1209. When renewing piles those injured in driving or driven materially out of line shall be replaced.

1210. When renewing batter piles they shall be driven to the inclination shown on standard plans for existing structures and shall require but slight bending before framing.

1211. When renewing timbers they shall be of the kind and size required. Timbers received not suitable shall be removed from the immediate location of work and reported to the proper official.

1212. When renewing frame timbers they shall be tightly fitted. Blocking and shimming must not be used in making joints. Timbers must be cut off with a saw.

1213. When renewing caps they shall have a uniform thickness, even bearing on the piles and sap side shall be placed downward.

1214. When renewing sash and sway braces they shall be properly framed and securely fastened to piles, posts and caps. Where the piles in a bent vary in size or are out of line filler blocks shall be used between the braces and piles, securely fastened and faced to obtain a bearing against all piles. Treated filler blocks shall be used with treated braces.

1215. When renewing stringers they shall have a uniform depth at supports, even bearing on the caps and sap edge placed downward.

1216. When renewing ties on open deck structures they shall be sized to a uniform thickness and shall be placed with the rough side upward, spaced regularly and cut to even length and line.

1217. When renewing guard timbers they shall be framed and securely fastened to the ties as called for on standard plans, laid to line and to a uniform surface.

1218. When renewing guard timbers where they are fastened to the ties by lag screws, the holes in the guard timbers shall be bored with augur bits $\frac{1}{16}$ inch, and in the ties $\frac{1}{4}$ inch less in diameter than the size of the lag screw.

Where the guard timbers are fastened to the ties with bolts, the holes in both the guard timbers and the ties shall be bored with an augur bit $\frac{1}{16}$ inch greater in diameter than the nominal diameter of the bolt. Where the guard timbers are fastened with boat spikes the holes in the guard timber and tie shall be the size of the spike. Lag screws must be screwed in, not driven.

1219. When replacing top portions of piles with posts, the old piles shall be cut off below where sound timber is found. Good joints shall be made between the old pile and the sill where entire bent is renewed and between the old pile and post where a single pile is replaced. The sill or post shall be securely fastened to the old pile. The posts shall be drift bolted or doweled to the sill. Pile bents having one or more posts shall be properly braced.

1220. Bearings of posts on sills shall preferably be directly over the piles, but if such bearing cannot be provided, then sills of sufficient strength to safely transfer the load from the posts to the piles shall be used. Framed bents on piles must be provided with longitudinal X braces.

Appendix C

(2B) RULES FOR MAINTENANCE OF OTHER TERMINAL STRUCTURES

B. R. Kulp, Chairman, Sub-Committee.

Oil Houses

1250. Oil storage facilities must be kept thoroughly grounded at all times and maintained in such a way that all pipes and connections will be tight.

Coaling Stations

1261. Special attention must be given to maintenance of bins, chutes, and working appurtenances of all coaling stations.

1262. Inspection must be made from time to time and corrective measures taken to keep shed free from dirt, coal dust or screenings.

1263. Fire protection apparatus must be inspected and tested at specified intervals and kept thoroughly tight and in working order.

1264. Coal must not be wet down either before or after going into a wooden coaling station.

Cinder Pits

1270. Brick or concrete track supports on cinder pits must be given close inspection and repairs promptly made of any defect found.

1271. Steel beams supporting tracks must be watched to see that the hot cinders have no effect on their strength and the rail fastenings kept in proper order.

1272. Water supply must be maintained at all times and strict supervision maintained to see that cinders dumped from locomotives are immediately wet down to keep the heat away from side walls and track supports.

1273. Drainage must be looked after frequently to see that catch basins are cleaned out to prevent cinders from being washed into the sewer.

1274. Racks must be maintained for clinker hooks and shaker bars so they can be hung up when not in use.

Turntables

1280. Refuse and dirt must be kept off the deck and out of the pit. The pit must be kept properly drained.

1281. Center bearing of turntables must be kept clean. At least once each year the turntables shall be jacked up and the center bearing thoroughly inspected, cleaned and oiled.

1282. Top flanges and cross bracing of turntables must be kept clean and when tie renewals are made top flanges given a coat of paint. At proper intervals entire table shall be cleaned and painted with approved structural steel paint.

1283. Inspection of and maintenance of turntables must not be undertaken without first notifying the operator.

1284. In severe weather, salt must not be used or fires built around turntables in such a manner as to damage the steel structure, to assist in turning. Where heat is necessary steam must be used when available.

1285. The distance between the ends of the yard rails and the ends of the rails on the turntables must be maintained not greater than ¾ inch, in order to avoid pounding when locomotive passes over the joint.

1286. Turntables must be maintained so that when tilted to such a position that the wheels at one end bear on the circle rail, the top of the rails on the table at this end and the top of the rails in the yard at the edge of the pit shall be at the same elevation.

1287. The end wheel journal bearings shall be kept thoroughly cleaned, well packed with waste and with suitable lubricating oil.

Track Scales

1290. Track scales must be numbered and referred to by number and location.

1291. Repairs to scale levers must be made only in a properly appointed scale shop.

1292. Scale parts must be kept clean and free from interference.

1293. Iron and steel parts, except knife-edges and bearing steels, must be painted when installed and at such other times as may be directed.

1294. Pivots and bearing steels must be protected from corrosion in such a manner as not to interfere with the proper working of the scale.

1295. Salt or other corroding compounds must not be used for thawing snow or ice about scales.

1296. Scale pits must be kept clean and properly drained and ventilated.

1297. Employees designated to clean and care for scales must be properly instructed.

Appendix D

(3) TITLES EMPLOYED TO DESIGNATE POSITIONS OF CORRESPONDING RANK IN MAINTENANCE OF WAY SERVICE

Richard Brooke, Chairman, Sub-Committee.

ASSISTANT ENGINEERS—MAINTENANCE OF WAY DEPARTMENT

(1) Assistant Division Engineer—Engineer who reports to the Division Engineer, supervises general maintenance work and acts for the Division Engineer in his absence.

(2) Assistant Engineer, Maintenance—Engineer who reports to the Division Engineer, is responsible for the preparation of plans and estimates and supervises field and office engineering work.

FOREMEN—MAINTENANCE OF WAY DEPARTMENT

(1) General Foreman—Supervisory officer responsible for the maintenance and construction of track on an assigned territory or assigned project.

(2) Section Foreman—Foreman responsible for the maintenance of track, roadbed and right of way on a designated territory.

(3) Extra Gang Foreman—Foreman of a floating gang engaged in laying rail, applying ballast or other track or roadway work usually requiring a larger organization than a section gang.

(4) Work Train Foreman—Foreman in general charge of a work train and a gang handling material and doing other work performed with a work train.

(5) Welder Foreman—Foreman in charge of building up rail ends, frogs and switches in and along the track.

(6) General Foreman, Bridges and Buildings—Supervisory officer responsible for the maintenance and construction of bridges and buildings on an assigned territory.

(7) Bridge and Building Foreman—Foreman in charge of maintenance and construction of bridges and buildings.

(8) Mason Foreman—Foreman in charge of maintenance and construction of masonry.

(9) Painter Foreman—Foreman in charge of the painting of bridges and buildings.

(10) Plumber Foreman—Foreman in charge of maintenance and construction of plumbing.

(11) Tinner Foreman—Foreman in charge of sheet metal work.

(12) Fence Foreman—Foreman in charge of maintenance and construction of fences.

(13) Water Service Foreman—Foreman in charge of maintenance and construction of water service facilities.

(14) Signal Foreman—Foreman in charge of maintenance and construction of signals and interlocking.

Appendix E

R. E. Warden, Chairman, Sub-Committee.

AN ACT to Regulate the Practices of Professional Engineering and Land Surveying; Creating a State Registration Board for Professional Engineers and Land Surveyors; Defining Its Powers and Duties; Also Imposing Certain Duties Upon the State and Political Subdivisions Thereof in Connection with Public Work; and Providing Penalties.

Section 1.—General Provisions.—Be it enacted by the General Assembly of State of .... that in order to safeguard life, health, and property, any person practicing or offering to practice the professions of engineering or of land surveying, shall hereafter be required to submit evidence that he is qualified so to practice and shall be registered as hereinafter provided; and it shall be unlawful for any person to practice or to offer to practice the professions of engineering or of land surveying, in this State, or to use in connection with his name or otherwise assume, use, or advertise any title or description tending to convey the impression that he is a professional engineer or a land surveyor, unless such person has been duly registered or exempted under the provisions of this Act.

Section 2.—Definitions.—The term, "professional engineer," as used in this Act, shall mean a person who represents himself to be such a professional engineer, either through the use of the term, "engineer," with or without qualifying adjectives, or through the use of some other title implying that he is such a professional engineer.

The term, "land surveyor," as used in this Act, shall mean any person who makes surveys for the determination of area, or the establishment of land boundaries, or the subdivision and platting of land.

The term, "Board," as used in this Act, shall mean the State Registration Board for Professional Engineers and Land Surveyors, provided for by this Act.

Section 3.—State Registration Board for Professional Engineers and Land Surveyors.—Appointment of Members.—Terms.—A State Registration Board for Professional Engineers and Land Surveyors is hereby created. The Board shall consist of five professional engineers, who shall be appointed by the Governor and shall have the qualifications required by Section 4. The members of the first Board shall be appointed within ninety days after the passage of this Act, to serve for the following terms: One member for one year, one member for two years, one member for three years, one member for four years, and one member for five years, from the date of their appointment, or until their successors are duly appointed and qualified. Every member of the Board shall receive a certificate of his appointment from the Governor and before beginning his term of office shall file with the Secretary of State his written oath for the faithful discharge of his official duty. Each member of the Board first appointed hereunder shall receive a certificate of registration under this Act from said Board. On the expiration of the term of any member, the Governor shall appoint for a term of five years a registered professional engineer, having the qualifications required by Section 4, to take the place of the member whose term on said Board is about to expire. Each member shall hold office until the expiration of the term for which such member is appointed or until a successor shall have been duly appointed and shall have qualified.

Section 4.—Qualifications of Members of Board.—Each member of the Board shall be a citizen of the United States and a resident of this State, and shall have been engaged in the practice of the profession of engineering

for at least ten years, and shall have been in responsible charge of engineering work for at least five years.

Section 5.—Compensation and Expenses of Board Members.—Each member of the Board shall receive the sum of .... dollars ($....) per diem when actually attending to the work of the Board or of any of its committees and for the time spent in necessary travel; and, in addition thereto, shall be reimbursed for all actual traveling, incidental, and clerical expenses necessarily incurred in carrying out the provisions of this Act.

Section 6.—Removal of Members of Board.—Vacancies.—The Governor may remove any member of the Board for misconduct, incompetency, neglect of duty, or for any other sufficient cause. Vacancies in the membership of the Board shall be filled by appointment by the Governor for the unexpired term.

Section 7.—Organization and Meetings of the Board.—The Board shall hold a meeting within thirty days after its members are first appointed, and thereafter shall hold at least two regular meetings each year. Special meetings shall be held at such times as the by-laws of the Board may provide. Notice of all meetings shall be given in such manner as the by-laws may provide. The Board shall elect annually from its members a chairman, a vice-chairman, and a secretary. A quorum of the Board shall consist of not less than three members.

Section 8.—Powers of the Board.—The Board shall have the power to make all by-laws and rules, not inconsistent with the Constitution and Laws of this State, which may be reasonably necessary for the proper performance of its duties and the regulations of the proceedings before it. The Board shall adopt and have an official seal.

In carrying into effect the provisions of this Act, the Board may, under the hand of its Chairman and the seal of the Board, subpœna witnesses and compel their attendance, and also may require the production of books, papers, documents, etc., in a case involving the revocation of registration or practicing or offering to practice without registration. Any member of the Board may administer oaths or affirmations to witnesses appearing before the Board. If any person shall refuse to obey any subpœna so issued, or shall refuse to testify or produce any books, papers, or documents, the Board may present its petition to the Court of .... of the County in which it may be in session, setting forth the facts, and thereupon such Court shall, in a proper case, issue its subpœna to such person, requiring his attendance before such Court and there to testify or to produce such books, papers, and documents, as may be deemed necessary and pertinent by the Board. Any person failing or refusing to obey the subpœna or order of the said Court may be proceeded against in the same manner as for refusal to obey any other subpœna or order of the Court.

Section 9.—Receipts and Disbursements.—The Secretary of the Board shall receive and account for all moneys derived under the provisions of this Act, and shall pay the same monthly to the State Treasurer, who shall keep such moneys in a separate fund to be known as the "Professional Engineers' Fund." Such fund shall be kept separate and apart from all other moneys in the Treasury, and shall be paid out only by warrant of the State Auditor upon the State Treasurer, upon itemized vouchers, approved by the Chairman and attested by the Secretary of the Board. All moneys in the "Professional Engineers' Fund" are hereby specifically appropriated for the use of the Board. The Secretary of the Board shall give a surety bond to this State in such sum as the Board may determine. The premium on said bond shall be regarded as a proper and necessary expense of the Board, and shall be paid out of the "Professional Engineers' Fund." The Secretary of the Board shall receive such salary as the Board shall determine in addition to the compensation and expenses provided for in Section 5. The Board may employ such clerical or other assistants as are necessary for the proper performance of its work, or may make expenditures of this fund for any purpose which in the opinion of the Board is reasonably necessary for the proper performance of its duties under this Act. Under no circumstances

shall the total amount of warrants issued by the State Auditor in payment of the expenses and compensation provided for in th's Act exceed the amount of the examination and registration fees collected as herein provided.

Section 10.—Records and Reports.—The Board shall keep a record of its proceedings and a register of all applications for registration, which register shall show (a) the name, age, and residence of each applicant; (b) the date of the application; (c) the place of business of such applicant; (d) his educational and other qualifications; (e) whether or not an examination was required; (f) whether the applicant was rejected; (g) whether a certificate of registration was granted; (h) the date of the action of the Board; and (i) such other information as may be deemed necessary by the Board.

The records of the Board shall be prima facie evidence of the proceedings of the Board set forth therein, and a transcript thereof, duly certified by the Secretary of the Board under seal, shall be admissible in evidence with the same force and effect as if the original were produced.

Annually, as of .... [insert date], the Board shall submit to the Governor a report of its transactions of the preceeding year, and shall also transmit to him a complete statement of the receipts and expenditures of the Board, attested by affidavits of its Chairman and its Secretary.

Section 11—Roster of Registered Engineers and Surveyors—A roster showing the names and places of business of all registered professional engineers and all registered land surveyors shall be prepared by the Secretary of the Board during the month of .. .. of each year, commencing one year from the date this law becomes effective. Copies of this roster shall be obtainable by each person so registered, and shall be placed on file with the Secretary of State.

Section 12.—General Requirements for Registration.—The following facts, established in the application, shall be regarded as minimum evidence satisfactory to the Board, that the applicant is qualified to practice as a professional engineer, or land surveyor, to wit:

(1) As a professional engineer:

(a) A specific record of seven or more years of active practice in engineering work of a character satisfactory to the Board and indicating that the applicant is competent to be placed in responsible charge of such work; or,

(b) Graduation from a school or college approved by the Board as of satisfactory standing, having a course in engineering of not less than four years; and a specific record of an additional three years of active practice in engineering work, of a character satisfactory to the Board, and indicating that the applicant is competent to be placed in responsible charge of such work.

(2) As a land surveyor:

(a) A specific record of five or more years of active practice in land surveying work of a character satisfactory to the Board and indicating that the applicant is competent to be placed in responsible charge of such work; or,

(b) Graduation in engineering from a school or college approved by the Board as of satisfactory standing and having a course in engineering of not less than four years; and an additional one year of active practice in surveying work of a character satisfactory to the Board and indicating that the applicant is competent to be placed in respons'ble cha-ge of such work.

Provided, that no person shall be eligible for registration as a professional engineer or land surveyor who is not of good character and repute.

In considering the qualifications of applicants, responsible charge of engineering teaching may be construed as responsible charge of work.

Graduation in engineering from a school of recognized standing shall be considered as equivalent to four years of active practice and the satisfactory completion of each year of work in such school without graduation shall be considered as equivalent to a half year of active practice. Graduation in a course other than engineering from a college or university of recognized standing shall be considered as equivalent to two years of active practice; provided, however, that no applicant shall receive credit for more than four years of active practice because of educational qualifications.

In cases where the evidence presented in the application does not appear to the Board to be conclusive or to warrant the issuing of a certificate of registration, the applicant may be required to present further evidence for the consideration of the Board, and may also be required to pass an oral or written examination, or both, as the Board may determine.

Section 13.—Applications and Registration Fees.—Applications for registration shall be on forms prescribed and furnished by the Board, shall contain statements made under oath showing the applicant's education and detail summary of his technical work, and shall contain not less than five references, of whom three or more shall have personal knowledge of his engineering experience.

The registration fee for professional engineers shall be twenty-five dollars ($25.00), fifteen dollars ($15.00) of which shall accompany application, the remaining ten dollars ($10.00) to be paid upon issuance of certificate. The registration fee for land surveyors shall be fifteen dollars ($15.00), which shall accompany application. Should the Board deny the issuance of a certificate of registration to any applicant the initial fee deposited shall be retained as an examination fee.

Section 14.—Examinations.—When oral or written examinations are required, same shall be held at such time and place as the Board shall determine. The scope of the examinations and the methods of procedure shall be prescribed by the Board with special reference to the applicant's ability to design and/or supervise engineering works, which shall insure the safety of life, health, and property. Examinations shall be given for the purpose of determining the qualifications of applicants for registration, separately in professional engineering and in land surveying. A candidate failing on examination may, at the discretion of the Board, be examined again.

Section 15.—Certificates.—Seals.—The Board shall issue a certificate of registration upon payment of registration fee as provided for in this Act, to any applicant who, in the opinion of the Board, has satisfactorily met all the requirements of this Act. In case of a registered engineer, the certificate shall authorize the practice of "professional engineering," and in the case of a registered land surveyor, the certificate shall authorize the practice of "land surveying." Certificates of registration shall show the full name of the registrant, shall have a serial number, and shall be signed by the Chairman and the Secretary of the Board under seal of the Board.

The issuance of a certificate of registration by this Board shall be evidence that the person named therein is entitled to all the rights and privileges of a registered professional engineer, or of a registered land surveyor, while the said certificate remains unrevoked or unexpired.

Each registrant hereunder shall upon registration obtain a seal of the design authorized by the Board, bearing the registrant's name and the legend, "Registered Professional Engineer," or "Registered Land Surveyor." Plans, specifications, plats, and reports issued by a registrant shall be stamped with the said seal during the life of registrant's certificate, but it shall be unlawful for any one to stamp or seal any documents with said seal after the certificate of the registrant named thereon has expired or has been revoked, unless said certificate shall have been renewed or re-issued.

Section 16.—Expirations and Renewals.—Certificates of registration shall expire on the last day of the month of .... following their issuance or renewal and shall became invalid on that date unless renewed. It shall be the duty of the Secretary of the Board to notify every person registered under this Act, of the date of the expiration of his cer-

tificate and the amount of the fee that shall be required for its renewal for one year; such notice shall be mailed at least one month in advance of the date of the expiration of said certificate. Renewal may be effected at any time during the month of .... by the payment of a fee of five dollars ($5.00). The failure on the part of any registrant to renew his certificate annually in the month of .... as required above shall not deprive such person of the right of renewal, but the fee to be paid for the renewal of a certificate after the month of .... shall be increased ten per cent for each month or fraction of a month that payment of renewal is delayed; provided, however, that the maximum fee for delayed renewal shall not exceed twice the normal renewal fee.

Section 17.—Firms, Partnerships, Corporations, and Joint Stock Associations.—A firm, or a co-partnership, or a corporation, or a joint stock association may engage in the practice of professional engineering in this State only provided such practice is carried on under the responsible direction of one or more registered professional engineers.

Section 18.—Practitioners at Time Act Became Effective.—At any time within one year after this Act becomes effective, upon due application therefor and the payment of a fee of twenty-five dollars ($25.00), the Board shall issue a certificate of registration, without oral or written examinations, to any professional engineer or land surveyor who shall submit evidence under oath satisfactory to the Board that he is of good character, has been a resident of the State of .... for at least one year immediately preceeding the date of his application, and was practicing professional engineering or land surveying at the time this Act became effective, such work being of a character satisfactory to the Board.

After this Act shall have been in effect one year, the Board shall issue certificates of registration only as provided for in Section 12 thereof.

Section 19.—Public Work.—After the first day of .... one thousand nine hundred and ...., it shall be unlawful for this State, or for any of its political sub-divisions, for any county, city, town, township, or borough to engage in the construction of any public work involving professional engineering, unless the plans and specifications and estimates have been approved by, and the construction supervised by a registered professional engineer; provided, that nothing in this Section shall be held to apply to any public work wherein the contemplated expenditure for the completed project does not exceed two thousand dollars ($2,000.00).

Section 20.—Exemptions.—The following persons shall be exempted from registration under the provisions of this Act, to wit:

(a) A person not a resident of and having no established place of business in this State, practicing or offering to practice herein the profession of engineering, when such practice does not exceed in the aggregate more than sixty days in any calendar year; provided, such person is legally qualified by registration to practice the said profession in this own State or country in which the requirements and qualifications for obtaining a certificate of registration are not lower than those specified in this Act.

(b) A person not a resident of and having no established place of business in this State, or who has recently become a resident thereof, practicing or offering to practice herein for more than sixty days in any calendar year the profession of engineering if he shall have filed with the Board an application for a certificate of registration and shall have paid the fee required by this Act. Such exemption shall continue only for such time as the Board reqiures for the consideration of the application for registration; provided, that such a person is legally qualified to practice said profession in his own State or country.

(c) An employee of a person holding a certificate of registration in this State who is engaged in the practice of the profession of engineering and an employee of a person exempted from registra-

tion by Classes (a) and (b) of this Section; provided, such practice does not include responsible charge of design or supervision.

(d) Officers and employees of the Government of the United States while engaged within this State in the practice of the profession of engineering or land surveying, for said Government.

(e) A person who practices the profession of engineering or land surveying exclusively as a regular employee of a public service company by rendering to such company engineering service in connection with its facilities which are subject to regulation, supervision, and control, in order to safeguard life, health, and property by the .... Commission of the State of ...., so long as such person is thus actually and exclusively employed and no longer; provided, that such Company shall have at least one engineer, registered under the provisions of this Act, in responsible charge of such Company's engineering work in this State.

Section 21.—(a) Reciprocity.—The Board shall, upon application therefor, and the payment of a fee of five dollars ($5.00), issue a certificate of registration as professional engineer to any person who holds an unexpired certificate of registration issued to him by the proper authority in any State or Territory or Possession of the United States or in any Country in which the requirements for the registration of professional engineers are of a standard not lower than that specified in this Act; provided, however, that the Engineering Registration Boards of said State, Territories, Possessions, or countries shall grant full and equal reciprocal registration rights and privileges to registrants of this Board. Agreements for reciprocity with other States, Territories, Possessions, or Countries may be entered into by the Board at its discretion.

(b) National Reciprocity.—The Board shall, upon application therefor and payment of a fee of five dollars ($5.00), issue a certificate of registration as professional engineer to any person who holds an unrevoked card or certificate of National reciprocal registration, issued by any State, Province, or Country in conformity with the regulations of the National Council of State Boards of Engineering Examiners, and who complies with the regulations of this Board, except as to qualifications and registration fee.

Section 22.—Revocation and Re-Issuances of Certificates.—The Board shall have the power to revoke the certificate of registration of any registrant who is found guilty of:

(a) The practice of any fraud or deceit in obtaining a certificate of registration.

(b) Any gross negligence, incompetency, or misconduct in the practice of professional engineering or land surveying as a registered professional engineer or land surveyor.

Any person may prefer charges of fraud, deceit, gross negligence, incompetency, or misconduct against any registrant. Such charges shall be in writing, and shall be sworn to by the person making them and shall be filed with the Secretary of the Board.

All charges, unless dismissed by the Board as unfounded or trivial, shall be heard by the Board within three months after the date on which they shall have been preferred.

The time and place for said hearing shall be fixed by the Board, and a copy of the charges, together with a notice of the time and place of hearing, shall be personally served on or mailed to the last known address of such registrant, at least thirty days before the date fixed for the hearing. At any hearing, the accused registrant shall have the right to appear personally and by counsel, to cross-examine witnesses appearing against him, and to produce evidence and witnesses in his own defense.

If, after such hearing, three or more members of the Board vote in favor of finding the accused guilty, the Board shall revoke the certificate of registration of such registered professional engineer or land surveyor.

The Board, for reasons it may deem sufficient, may re-issue a certificate of registration to any person whose certificate has been revoked, providing three or more members of the Board vote in favor of such re-issuance. A new certificate of registration, to replace any certificate revoked, lost, destroyed, or multilated, may be issued, subject to the rules of the Board and a charge of three dollars ($3.00) shall be made for such issuance.

Section 23.—Violations and Penalties.—Any person who shall practice, or offer to practice, the profession of engineering or land surveying in this State without being registered or exempted in accordance with the provisions of this Act, or any person presenting or attempting to use as his own the certificate of registration of another, or any person who shall give any false or forged evidence of any kind to the Board or to any member thereof in obtaining a certificate of registration, or any person who shall falsely impersonate any other registrant of like or different name, or any person who shall attempt to use an expired or revoked certificate of registration, or shall violate any of the provisions of this Act, shall be guilty of a misdeameanor, and shall, upon conviction, be sentenced to pay a fine of not less than one hundred dollars ($100.00), nor more than five hundred dollars ($500.00), or suffer imprisonment for a period not exceeding three months, or both.

It shall be the duty of all duly constituted officers of the law of this State, or any political subdivision thereof, to enforce the provisions of this Act and to prosecute any persons violating same. The Attorney General of the State or his assistant shall act as legal adviser of the Board and render such legal assistance as may be necessary in carrying out the provisions of this Act.

Section 24.—Invalid Sections.—If any section or sections of this Act shall be declared unconstitutional or invalid, this shall not invalidate any other section of this Act.

Section 25.—Repeal of Conflicting Legislation.—All laws or parts of laws in conflict with the provisions of this Act shall be, and the same are hereby, repealed.

REPORT OF COMMITTEE V—TRACK

J. V. Neubert, *Chairman;*
H. G. Aberg,
J. B. Akers,
C. A. Alden,
W. G. Arn,
W. H. Bevan,
L. H. Bond,
R. W. E. Bowler,
C. W. Breed,
W. G. Brown,
E. W. Caruthers,
A. M. Clarke,
H. R. Clarke,
H. S. Clarke,
J. E. Deckert,
J. W. DeMoyer,
L. W. Deslauriers,
J. J. Desmond,
J. H. Dymock,
C. J. Geyer,
W. J. Harris,
O. F. Harting,
F. W. Hillman,
E. T. Howson,
W. G. Hulbert,
T. T. Irving,
F. J. Jerome,

C. R. Harding, *Vice-Chairman;*
H. D. Knecht,
J. de N. Macomb,
F. H. Masters,
C. M. McVay,
J. C. Mock,
J. B. Myers,
A. J. Neafie,
G. A. Peabody,
O. C. Rehfuss,
C. J. Rist,
P. T. Robinson,
W. L. Roller,
E. M. T. Ryder,
I. H. Schram,
G. J. Slibeck,
G. L. G. Smith,
T. Speiden, Jr.,
G. M. Strachan,
C. R. Strattman,
J. B. Strong,
E. D. Swift,
T. P. Warren,
J. R. Watt,
H. N. West,
J. G. Wishart,

Committee.

To the American Railway Engineering Association:

Your Committee respectfully presents reports on the subjects assigned, as follows:

Revision of Manual—Subjects 1, 2, 3 and 4 (Appendices A, B, C and D).

(1) Specifications for steel tie plates (Appendix A).

(2) Superelevation of the outer rail on curves in connection with the degree of curvature, gradient, the maximum speed of trains, traffic, number of tracks, etc. (Appendix B).

(3) String lining of curves by the chord method and prepare tables suitable for the use of trackmen (Appendix C).

(4) Temperature expansion for laying rails (Appendix D).

(5) Plans and specifications for track tools, collaborating with Committees I—Roadway, II—Ballast, and XXII—Economics of Railway Labor (Appendix E).

(6) Plans for switches, frogs, crossings, slip switches, etc. (Appendix F).

(7) Track construction in paved streets, collaborating with Committee IX—Grade Crossings (Appendix G).

(8) Corrosion of rail and fastenings in tunnels, collaborating with Committee IV—Rail (Appendix H).

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(9) Methods of reducing rail wear on curves, with particular reference to lubricating the rail or wheel flanges, collaborating with Committee IV—Rail (Appendix I).

(10) Cause and effect of brine drippings, and submit recommendations, collaborating with Committee IV—Rail, XV—Iron and Steel Structures, and the Merchanical Division, A.R.A. (Appendix J).

(11) Gage of track and elevation of curves, with reference to the use of roller bearings on railway equipment, collaborating with the Mechanical Division, A.R.A. (Appendix K).

(12) Effect of materials in track on the design of tie plates and punching thereof, together with the interrelation of slotting of joint bars and sizes of track spikes, collaborating with Committee IV—Rail (Appendix L).

Action Recommened

(1) That revisions recommended in Appendices A and D be approved for publication in the Manual.

(2) That plan No. 510 in Appendix F be adopted as recommended practice and published in the Manual and that Plans No. 260 and No. 262 in Appendix F be received as information, as outlined in this report, and that the subject be continued.

(3) That the reports in Appendices B, I and J be received as information and the subjects discontinued.

(4) That the progress reports in Appendices C, E, G, H, K and L be received as information and the subjects continued.

Respectfully submitted,

THE COMMITTEE ON TRACK,

J. V. NEUBERT, *Chairman.*

Appendix A

(1-A) REVISION OF SPECIFICATIONS FOR STEEL TIE PLATES

E. D. Swift, Chairman, Sub-Committee; J. V. Neubert, C. R. Harding, J. B. Akers, H. R. Clarke, H. S. Clarke, J. de N. Macomb, F. H. Masters, W. L. Roller, G. M. Strachan, J. G. Wishart.

In the Specifications for Steel Tie Plates, on pages 244, 245 and 246 of the 1929 Manual, withdraw Section 11 (b) and substitute revised version of this Section; also add Section 3 (d) and 11 (f).

Present Form

Section 11 (b). For plates with shoulders parallel to the direction of the rolling, a variation of $\frac{1}{32}$ in. in thickness, $\frac{1}{8}$ in. in rolled width and $\frac{3}{16}$ in. sheared length will be permitted.

Revised Form

Section 11 (b). For plates with shoulders parallel to the direction of rolling, a variation of $\frac{1}{32}$ in. in thickness, $\frac{1}{8}$ in. in rolled width and $\frac{3}{16}$ in. in sheared length will be permitted when no camber is required. When rolled in camber is specified a variation of $\frac{1}{4}$ in. in sheared length will be permitted.

Additional sections recommended:

Copper

Section 3 (d). When copper is specified the percentage contained in the steel shall be not less than 0.20 of 1 per cent.

Section 11 (d). Regardless of variations otherwise permissible, the weights to be paid for shall not exceed the weights calculated from the specified dimensions by more than 3 per cent.

(1-B) REVISION OF SPECIFICATIONS FOR SOFT STEEL TRACK SPIKES

E. D. Swift, Chairman, Sub-Committee; J. V. Neubert, C. R. Harding, J. B. Akers, H. R. Clarke, H. S. Clarke, J. de N. Macomb, F. H. Masters, W. L. Roller, G. M. Strachan, J. G. Wishart.

The Committee now has under consideration the revision of Specifications for Soft Steel Track Spikes, as well as the possibility of a change in design.

Appendix B

(2) SUPERELEVATION OF THE OUTER RAIL ON CURVES IN CONNECTION WITH THE DEGREE OF CURVATURE, GRADIENT, THE MAXIMUM SPEED OF TRAINS, TRAFFIC, NUMBER OF TRACKS, ETC.

C. W. Breed, Chairman, Sub-Committee; J. V. Neubert, C. R. Harding, W. H. Bevan, L. H. Bond, R. W. E. Bowler, H. R. Clarke, J. J. Desmond, C. J. Geyer, W. J. Harris, F W. Hillman, F. J. Jerome, H. D. Knecht, C. M. McVay, J. B. Myers, G. L. G. Smith, C. R. Strattman, J. R. Watt.

"After careful consideration of this subject by the Sub-Committee at various meetings, we wish to recommend that this subject be withdrawn. We feel that the Manual and the Proceedings of the Association contain very complete information on this subject. If we attempt to tabulize each case we will probably be misunderstood and complications will result." Reported at July meeting.

In support of this recommendation the following facts are submitted:

There are 112 pages of data about the superelevation of the outer rail on curves in the publications of the Association. The information contained therein are the best views of the engineering members over a period of thirty years. There are formulas and full information as to their development for equilibrium superelevations, for superelevations in which resultant of forces passes through edge of middle third, etc.; there are tables of superelevations for most of the formulas shown.

There are tables and graphs showing speeds of trains through turnouts, and general information on all cases of superelevation. In addition to this the specific experience and individual curve elevation tables and practices of some forty Class I railroads appears in the 1929 Proceedings.

When we consider the infinite number of superelevations required on all the individual curves on all the railroads we see that it is not practical to attempt to tabulate or classify them. An Engineer desiring to set up the superelevations over a particular railroad will find from the Proceedings and Manual that he must first determine the speed of traffic over each curve. If both passenger and freight traffic are in operation over the curve he knows that there will have to be a compromise in the amount of superelevation. He cannot give the passenger traffic the full benefit of equilibrium superelevation because he does not wish to subject the inner rail of the curve to the excessive wear from slower moving freight traffic.

If the freight traffic over the particular curve is comparatively fast due to favorable gradient or other causes, then the Engineer should follow the practice of many Engineers as shown in 1929 Proceedings and choose the equilibrium elevation for a speed 5 to 10 miles less than the maximum speed of passenger traffic over that curve.

On other lines where there is a preponderance of comparatively slow freight traffic it may become expedient to superelevate the outer rail of curves for the speed of this traffic, restricting the speed of passenger trains, if necessary, to preserve safety and comfort over those curves.

If there is only passenger traffic or only freight traffic over a particular curve, the information in the Proceedings indicates to the Engineer that he should superelevate that particular curve the amount shown as equilibrium superelevation in the Manual for the maximum speed determined for the passenger train over its particular curve or the freight traffic over its particular curve.

If these basic rules are followed in determining superelevation and first consideration is given to safe travel, there is not required any other information than now appears in the Publications of the Association.

Appendix C

(3) STRING LINING OF CURVES BY THE CHORD METHOD AND PREPARE TABLES SUITABLE FOR THE USE OF TRACKMEN

C. W. Breed, Chairman, Sub-Committee; J. V. Neubert, C. R. Harding, W. H. Bevan, L. H. Bond, R. W. E. Bowler, H. R. Clarke, J. J. Desmond, C. J. Geyer, W. J. Harris, F. W. Hillman, F. J. Jerome, H. D. Knecht, C. M. McVay, J. B. Myers, G. L. G. Smith, C. R. Strattman, J. R. Watt.

The Committee reports progress. We have secured a number of string lining tables but feel that they must be amplified by more complete explanation before they can be generally useful. Tables are also being prepared on the basis of the 10-chord spiral appearing in the Manual using the length of spiral tabulated therein. We recommend that the subject be continued.

Appendix D

(4) TEMPERATURE EXPANSION FOR LAYING RAILS

J. V. Neubert, Chairman, Sub-Committee; C. R. Harding.

A questionnaire was sent out both in 1929 and in 1930 in regard to determining whether we should adhere to the present temperature expansion as contained in the Manual of 1929, page 243, or have the same modified. The allowance of expansion as shown in the present Manual is as follows:

(1) When laying rails their temperature should be taken by applying a thermometer to head of rail. To allow for expansion, openings between the ends of rail should be as follows:

Temperature of Rail-Degree Fahr.	*160 Jts. Per Mile 33′0″ Rails*	*135 Jts. Per Mile 39′0″ Rails*	*117 Jts. Per Mile 45′0″ Rails*
—20° to 0°	5/16″	3/8″	7/16″
0° to 25°	1/4″	9/32″	11/32″
25° to 50°	3/16″	7/32″	1/4″
50° to 75°	1/8″	1/8″	5/32″
75° to 100°	1/16″	1/16″	1/16″
Over 100°	Laid Close	Laid Close	Laid Close

The other four schemes considered by the Track Committee are as follows:

Scheme No. 1

Temperature of Rail-Deg. Fahr.	*160 Jts. Per Mile 33′0″ Rails*	*135 Jts. Per Mile 39′0″ Rails*
0 to 25	3/16″	1/4″
26 to 50	1/8″	3/16″
51 to 75	1/8″	1/8″
76 to 100	1/16″	1/16″
Over 100	None	None

Scheme No. 2

Temperature of Rail-Deg. Fahr.	*160 Jts. Per Mile 33′0″ Rails*	*135 Jts. Per Mile 39′0″ Rails*
0 to 32	1/4″	5/16″
33 to 70	3/16″	1/4″
71 to 100	1/8″	1/8″
Over 100	None	None

Scheme No. 3

Temperature of Rail-Deg. Fahr.	*160 Jts. Per Mile 33′0″ Rails*	*135 Jts. Per Mile 39′0″ Rails*
0 to 25	1/4″	5/16″
26 to 50	3/16″	1/4″
51 to 75	3/16″	3/16″
76 to 100	1/8″	1/8″
Over 100	None	None

Scheme No. 4

Temperature of Rail-Deg. Fahr.	*160 Jts. Per Mile 33′0″ Rails*	*135 Jts. Per Mile 39′0″ Rails*
0 to 60	3/16″	1/4″
61 to 100	1/8″	1/8″
Over 100	None	None

will be superseded by this new series and accordingly will be withdrawn later.

The Committee has prepared two typical plans, namely, plans No. 260 of No. 8 frogs and No. 262 of No. 10 frogs, which are now offered for information to invite criticism for reference and guidance in completing the new series in question.

It will be noted that plan No. 262 shows No. 10 rail bound manganese steel, bolted rigid and spring rail frogs of the same length. These frogs can be readily interchanged. In the preparation of plan No. 260 of No. 8 frogs it was found that the spring rail frog could not be efficiently made to the economical shorter length recommended for rail bound manganese steel and bolted rigid frogs. The No. 8 rail bound manganese steel and bolted rigid frogs are therefore not interchangeable with the No. 8 spring rail frogs, it being considered inadvisable, in view of the fact that No. 8 bolted rigid frogs are used in considerably larger quantity than No. 8 spring rail frogs, to increase the length of the bolted rigid frog in this instance to conform to the length of the spring rail frog.

In March of 1929, the Committee presented as information to invite criticism plan No. 510, dated November, 1928, of manganese steel one-piece guard rail on six ties. This plan has been revised by addition of notes covering marking and setting for the different angle turnouts in most common use and in some other minor particulars, and is now presented, with revision date October, 1930, for adoption as recommended practice.

Plans presented in this Appendix have been prepared in conference with the Standardization Committee of the Manganese Track Society.

The Committee also has under consideration revisions of plans of open hearth guard rails, plans No. 501 and No. 502, adopted March, 1921, also revision, if needed, of flangeways and other details in present A.R.E.A Trackwork plans to conform to the latest A.R.A. Mechanical Division Standards on wheel flanges and gage settings. Reports on these subjects and other pertinent details will be presented at a later date.

Conclusions

The Committee recommends that the following plan submitted herewith be adopted as recommended practice and printed in the Manual.

Plan No. 510, dated Oct., 1930, A.R.E.A. manganese steel one-piece guard rail on six ties.

The Committee also recommends that the following plans submitted herewith be received as information.

Plan No. 260, dated Oct., 1930, A.R.E.A. No. 8 frogs for medium weight rails, rail bound manganese steel, bolted rigid, spring rail and solid manganese steel.

Plan No. 262, dated Oct., 1930, A.R.E.A. No. 10 frogs for medium weight rails, rail bound manganese steel, bolted rigid, spring rail and solid manganese steel.

The Committee recommends that this subject be continued.

Appendix E

(5) PLANS AND SPECIFICATIONS FOR TRACK TOOLS

G. M. Strachan, Chairman, Sub-Committee; J. V. Neubert, C. R. Harding, J. B. Akers, W. H. Bevan, L. H. Bond, C. W. Breed, W. G. Brown, E. W. Caruthers, A. M. Clarke, H. R. Clarke, J. E. Deckert, J. W. DeMoyer, C. J. Geyer, E. T. Howson, T. T. Irving, J. B. Myers, A. J. Neafie, W. L. Roller, E. M. T. Ryder, C. R. Strattman, J. R. Watt, J. G. Wishart.

In Volume 31, Bulletin 321, November, 1929, beginning on page 555, the Committee submitted for information general specifications, chemical and hardness specifications, and inspection and physical tests specifications for track tools, and specifications for hickory handles for track tools. Also, plans and specifications for track shovels and ballast forks.

The Committee has no further plans to offer at this time, and recommends that the above mentioned specifications and plans be considered for another year as information, and that the subject be continued.

Appendix F

(6) PLANS FOR SWITCHES, FROGS, CROSSINGS, SLIP SWITCHES, ETC.

C. R. Harding, Chairman, Sub-Committee; J. V. Neubert, H. G. Aberg, J. B. Akers, C. A. Alden, L. H. Bond, W. G. Brown, E. W. Caruthers, J. W. DeMoyer, L. W. Deslauriers, J. H. Dymock, O. F. Harting, W. G. Hulbert, T. T. Irving, J. de N. Macomb, F. H. Masters, J. C. Mock, A. J. Neafie, G. A. Peabody, O. C. Rehfuss, C. J. Rist, E. M. T. Ryder, I. H. Schram, G. J. Slibeck, G. M. Strachan, J. B. Strong, H. N. West, J. G. Wishart.

The convenience of having for ready reference various types of frogs of the same frog number on the same plan, as plans Nos. 271 to 292 of frogs for heavy rails submitted at the March meetings in 1929 and 1930, has suggested the preparation of a similar series of plans for medium weight rails.

This series of plans, for medium weight rails, is to cover the same general data as plans of frogs for heavy rails, namely, rail bound manganese steel, bolted rigid, spring rail, and solid manganese steel types of frogs, as may be applicable to the different frog numbers, showing general details with definite references for further detailed dimensions and specifications and showing also uniform tie layouts for any type of guard rail, including the six-tie manganese steel one-piece design.

Some of the existing plans of frogs for medium weight rails are in need of revision, which will be taken into consideration when preparing this new series, and plans No. 305, No. 308 and No. 321, which also require revision,

Appendix G

(7) TRACK CONSTRUCTION IN PAVED STREETS

E. W. Caruthers, Chairman, Sub-Committee; J. V. Neubert, C. R. Harding, C. A. Alden, W. G. Brown, A. M. Clarke, H. S. Clarke, J. E. Deckert, J. W. DeMoyer, O. F. Harting, W. G. Hulbert, J. de N. Macomb, J. C. Mock, J. B. Myers, A. J. Neafie, G. A. Peabody, O. C. Rehfuss, P. T. Robinson, E. M. T. Ryder, G. J. Slibeck, T. Speiden, Jr., C. R. Strattman, J. B. Strong, T. P. Warren, H. N. West.

The Committee reports progress. Information on this subject is not developed sufficiently to warrant a report this year, and it is recommended that the subject be continued.

Appendix H

(8) CORROSION OF RAIL AND FASTENINGS IN TUNNELS

C. J. Geyer, Chairman, Sub-Committee; J. V. Neubert, C. R. Harding, H. G. Aberg, J. B. Akers, L. H. Bond, L. W. Deslauriers, J. H. Dymock, W. J. Harris, F. W. Hillman, H. D. Knecht, F. H. Master, C. M. McVay, O. C. Rehfuss, I. H. Schram, T. P. Warren.

The Sub-Committe's progress report at the Convention last year was to the effect that corrosion is negligible in tunnels under 1000 feet in length, medium in tunnels 1000 to 2000 feet in length, heavy in steam operated tunnels over 2000 feet in length where special drainage has not been provided. Study of replies to questionnaires received too late to include in last report and further study of information in questionnaires making up last year's report, tend to confirm the opinion that corrosion is materially reduced by good drainage and good ventilation, and further minimized by coating the rails and fastenings with a heavy oil, or some paints.

The Sub-Committee is now attempting to find the money loss account of corrosion and the approximate cost of preventative measures.

This report is submitted as information and further study is recommended, and the subject to be continued.

Appendix I

(9) METHODS OF REDUCING RAIL WEAR ON CURVES, WITH PARTICULAR REFERENCE TO LUBRICATING THE RAIL OR WHEEL FLANGES

C. M. McVay, Chairman, Sub-Committee; J. V. Neubert, C. R. Harding, W. G. Arn, W. H. Bevan, R. W. E. Bowler, L. W. Deslauriers, J. J. Desmond, W. J. Harris, E. T. Howson, F. J. Jerome, H. D. Knecht, C. J. Rist, P. T. Robinson, I. H. Schram, G. L. G. Smith, J. B. Strong, E. D. Swift.

Your Committee has been investigating the subject assigned for three years. Reports have been presented in Bulletin 314, of February, 1929, Vol. 30, page 924, of Proceedings, and Bulletin 321 of November, 1929, Vol. 31, page 592, of Proceedings.

In report contained in Bulletin 314 above, your attention is directed to Exhibits A and B covering data prepared by the Norfolk and Western Railway on several oiling locations. Exhibits C and D of report contained in Bulletin 321 cover the same rail. The Committee now presents Exhibits E and F covering data for one more year (1930) on the same rail. Section 15 shown in original Exhibits A and B is blank due to rail having been relaid in this location. The rail on these 5 curves has now had five years' service (laid in 1925) and is still in service. This is due to the application of oil as the high rail on these curves had to be renewed at least once per year prior to the adoption of the practice of oiling.

Cost data for oiling by hand and machine is shown in reports mentioned above. The Committee has nothing to add to this phase of the subject at this time. Cost figures secured vary so greatly due to variations in traffic and local conditions that it is impossible to reduce them to formula. In most cases, however, the Commttee finds that the cost of oil application is a small item compared to the benefits gained.

The Committee feels that the information now being secured by it is largely duplication and that it is not necessary to go into this matter further at this time. The majority of roads are familiar with the practice.

Attention is called to the fact that curve wear on the outer rail of curves can be reduced by the placing of guard rails on the opposite side. Many roads also are using alloy rails, such as rolled manganese rail, to prolong the life cycle of rail on curves.

The work assigned this Committee calls particular attention to oiling and the Committee recommends that the following conclusions be adopted and published in the Manual and the subject be discontinued.

Conclusions

1. The lubrication of the gage side of outer rails on curves is economical where the life of rail is limited by excessive flange wear on the outer rail.

2. The lubricant may be applied (a) by an automatic mechanical device attached to the rail and operated by passing trains, (b) by hand

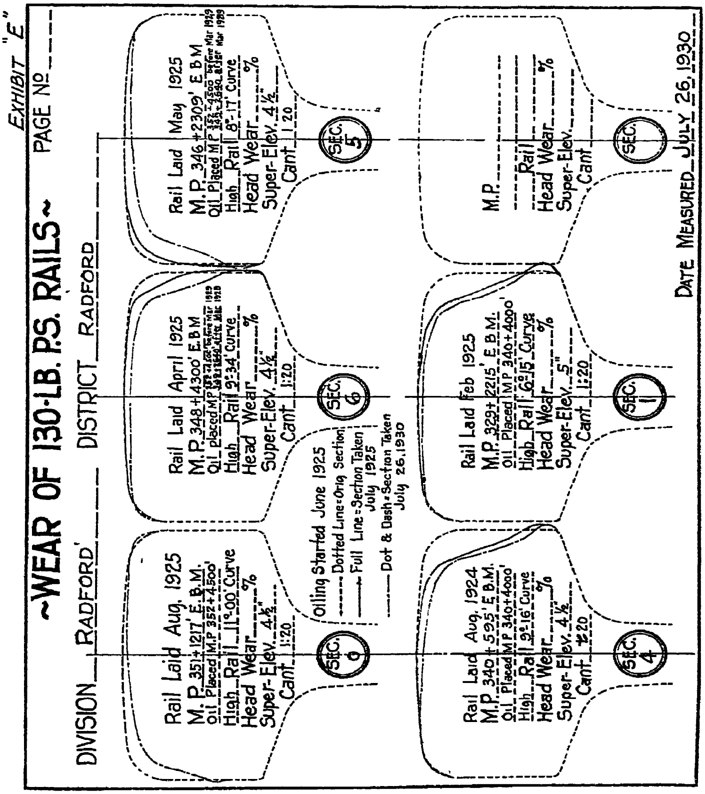


EXHIBIT "E"
~WEAR OF 130-LB. P.S. RAILS~
PAGE No
DIVISION RADFORD
DISTRICT RADFORD
Rail Laid Aug. 1925
M. P. 351+1217' E.B.M.
Oil Placed M.P. 352+4500'
High Rail 11°-00' Curve
Head Wear %
Super-Elev. 4½"
Cant 1:20
SEC. 6
Rail Laid April 1925
M.P. 348+4300' E.B.M.
High Rail 9°34' Curve
Head Wear %
Super-Elev. 4½"
Cant 1:20
SEC. 6
Rail Laid May 1925
M.P. 346+2309' E.B.M.
High Rail 8°-17' Curve
Head Wear %
Super-Elev. 4½"
Cant 1:20
SEC. 5
Oiling Started June 1925
Dotted Line = Orig. Section
Full Line = Section Taken July 1925
Dot & Dash = Section Taken July 26, 1930
Rail Laid Aug. 1924
M.P. 340+595' E.B.M.
Oil Placed M.P. 340+4000'
High Rail 2°16' Curve
Head Wear %
Super-Elev. 4½"
Cant 1:20
SEC. 4
Rail Laid Feb 1925
M.P. 329+2215' E.B.M.
Oil Placed M.P. 340+4000'
High Rail 6°15' Curve
Head Wear %
Super-Elev. 5"
Cant 1:20
SEC. 1
M.P.
Rail
Head Wear %
Super-Elev.
Cant
SEC. 1
DATE MEASURED JULY 26, 1930

EXHIBIT "F"

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	6	5	2	[illegible]
Rails [illegible] Removed	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Average Curvature [illegible]	11°-0'	5°-34'	3°-11'	8°-16'	6°-15'
Superelevation	4½	4½	4½	4½	5
Distance [illegible] Miles	1.62	4.60	6.41	0.65	1.12
Before Oiling					
Million Gross Ton Miles Traffic	—	167.57	80.51	79.92	38.43
Square Inches of Rail Wear	—	.6089	.6045	[illegible]	[illegible]
Sq. In. Wear per Million Gr. Ton Miles	—	[illegible]	[illegible]	[illegible]	[illegible]
Rail in Service	—	[illegible]	[illegible]	[illegible]	[illegible]
After Oiling					
Million Gross Ton Miles Traffic	571.34	543.94	[illegible]	[illegible]	[illegible]
Square Inches of Rail Wear	0.248	0.230	0.562	[illegible]	0.210
Sq. In. Rail Wear per Million Gr. Ton Miles	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Rail in Service after Oiling Began	29 Mo.	61 Mo.	61 Mo.	61 Mo.	61 Mo.
Ratio of Wear—Oiled Rails to Unoiled Rails	—	1:13.3	1:18.1	1:19.4	1:13.2

Date Measured—July 28, 1922

after the passing of each train, where the location is in territory regularly patrolled by a cut, tunnel or other watchman.

3. To insure the best results special lubricants selected for the purpose should be used.

4. The distance that the lubricant is carried by the flanges can be readily determined and application governed accordingly. This will vary due to number of curves involved, grade conditions, amount of traffic, etc.

5. Other economies gained from this practice are (a) decreased gaging of track on curves, (b) decreased wear on engine and car wheel flanges, (c) decreased flow of metal on inner rail which is due to widening of gage.

Appendix J

(10) CAUSE AND EFFECT OF BRINE DRIPPINGS, AND SUBMIT RECOMMENDATIONS

W. G. Arn, Chairman, Sub-Committee; J. V. Neubert, C. R. Harding, H. R. Clarke, J. E. Deckert, J. J. Desmond, O. F. Harting, F. W. Hillman, E. T. Howson, T. T. Irving, T. Speiden, Jr., G. M. Strachan, C. R. Strattman, T. P. Warren, J. R. Watt.

At the Convention last March, the Committee submitted the following recommendations, which are shown in Bulletin 321, of November, 1929, Volume 31, pages 596-597:

(1) That the railroads require the maintenance of brine retaining apparatus on the meat-carrying or bunker type of cars in the best possible shape.

(2) That the Mechanical Division continue vigorously its efforts to perfect a design for the fruit and vegetable carrying car that will permit of installation and operation of brine retainers on this type of car.

(3) That the effort on the part of the car companies and refrigerant manufacturers to find a refrigerant which will take the place of ice and salt, and eliminate entirely the making of brine, and consequently its damage, be encouraged by the A.R.A. and the individual railroads.

(4) That in the meantime the railroads continue the application to their structures of the protective agents mentioned and being tried on the various systems, and further to make tests of any additional agents which offer promising possibilities.

The Convention accepted the above report as information and the subject was reassigned.

Conclusions

This report is recommended for adoption, request to be made on the American Railway Association that it take action on above recommendations Nos. 1, 2 and 3 (the maintenance of brine retaining apparatus is covered in American Railway Association Code of Rules (M.C.B.), Rule 3, Article r, paragraph 2, which reads as follows:

> "Rule 3—Cars not conforming to the following requirements will not be accepted in interchange, or from car owners, as specified."
>
> "(r) (2) Refrigerator cars equipped with brine tanks: Suitable device for retaining the brine between icing stations. From owners.")

It is recommended that the subject be discontinued.

Appendix K

(11) GAGE OF TRACK AND ELEVATION OF CURVES, WITH REFERENCE TO THE USE OF ROLLER BEARINGS ON RAILWAY EQUIPMENT

C. W. Breed, *Chairman, Sub-Committee;* J. V. Neubert, C. R. Harding, W. H. Bevan, L. H. Bond, R. W. E. Bowler, H. R. Clarke, J. J. Desmond, C. J. Geyer, W. J. Harris, F. W. Hillman, F. J. Jerome, H. D. Knecht, C. M. McVay, J. B. Myers, G. L. G. Smith, C. R. Strattman, J. R. Watt.

The Committee reports progress. Information on this subject is not developed sufficiently to warrant a report this year, and it is recommended that the subject be continued.

Appendix L

(12) EFFECT OF EXISTING MATERIALS IN TRACK ON THE DESIGN OF TIE PLATES AND PUNCHING THEREOF, TOGETHER WITH THE INTERRELATION OF SLOTTING OF JOINT BARS AND SIZE OF TRACK SPIKES

J. de N. Macomb, *Chairman, Sub-Committee;* J. V. Neubert, C. R. Harding, W. G. Arn, W. H. Bevan, R. W. E. Bowler, W. G. Brown, E. W. Caruthers, A. M. Clarke, H. S. Clarke, J. W. DeMoyer, L. W. Deslauriers, C. J. Geyer, W. J. Harris, O. F. Harting, F. W. Hillman, F. J. Jerome, H. D. Knecht, F. H. Masters, J. B. Myers, A. J. Neafie, C. J. Rist, P. T. Robinson, W. L. Roller, I. H. Schram, G. L. G. Smith, T. Speiden, Jr., E. D. Swift, J. R. Watt, J. G. Wishart.

The Committee reports progress. Information on this subject is not developed sufficiently to warrant a report this year, and it is recommended that the subject be continued.

REPORT OF COMMITTEE I—ROADWAY

C. W. Baldridge, *Chairman;*
M. M. Backus,
H. B. Barry,
A. L. Bartlett,
E. J. Bayer,
A. E. Botts,
W. G. Brown,
T. A. Burgess,
Paul Chipman,
J. F. Dobson,
L. J. Drumeller,
J. D. Elder,
G. S. Fanning,
J. L. Fergus,
J. A. Given,
J. S. Goodman,
Daniel Hillman,
Noah Johnson,
R. L. Kittredge,
G. E. Ladd,
F. W. Hillman, *Vice-Chairman;*
Harold W. Legro,
E. R. Lewis,
H. T. Livingston,
R. J. Middleton,
W. F. Monahan,
W. A. Murray,
J. A. Noble,
E. C. Oyler,
T. M. Pittman,
W. C. Pruett,
W. M. Ray,
C. S. Robinson,
P. T. Simons,
E. M. Smith,
W. C. Swartout,
H. M. Swope,
Jamison Vawter,
O. H. Wainscott,
Thomas Walker,

Committee.

To the American Railway Engineering Association:

Your Committee respectfully presents herewith its report covering the following subjects:

(1) Revision of Manual.

(2) Methods of roadbed drainage, including study of deformations of roadbed in the light of data developed by Special Committee on Stresses in Railroad Track, with special reference to drainage.

(3) Influences affecting the life of fence wire and methods for preventing its corrosion.

(4) Permanent roadbed construction, collaborating with Committees V—Track, VIII—Masonry, and Special Committee on Stresses in Railroad Track.

(5) Good practices in grading, including making embankment and excavation by use of various kinds of equipment and by other methods.

(6) Drainage areas, water runoffs and the proper sizes of waterway openings required under varying conditions.

(7) Methods of correcting soft spots in railway roadbed where it is impracticable to stabilize by drainage.

(8) Use of highway crossing plank and substitutes therefor, collaborating with Committees V—Track, and IX—Grade Crossings.

(9) Methods of roadway cross-sectioning calculations, measurements for monthly and final estimates, etc.

(10) Cause and prevention of heaving of track, due to frost action, and maintenance methods while the effects of heaving are present, collaborating with Committee V—Track.

(11) Furnish the Special Committee on Clearances the information required by it pertaining to roadway.

Bulletin 330, October, 1930.

Action Recommended

1. It is recommended that the revisions of the Manual, the withdrawals from the Manual and insertions into the Manual as offered in Appendix A, be accepted and the Manual be revised in accordance therewith.

2. That the finding of the Committee as given in Appendix B, Methods of Roadbed Drainage, beginning at the heading "Roadbed Drainage," to the subheading "Recommendations," be adopted for inclusion in the Manual and that paragraphs 1, 2, 3 and 4 of page 41 and paragraph 1 of page 49 in the 1929 issue of the Manual be withdrawn.

3. On the subject of "Influences affecting the life of fence wire" the Committee's report is given in Appendix C and it is offered as information and for discussion.

4. On the subject of Permanent Roadbed the Committee's report is given in Appendix D and is offered as information.

5. On the subject of Good Practices in Grading, the Committee's report is given in Appendix E, and it is offered as information and for discussion.

6. On the subject of Drainage Areas and Water Runoff, the Committee reports progress.

7. On the subject of Methods of Correcting Soft Spots in Roadbed, the Committee reports progress.

8. On the subject of Crossing Plank, the report of the Committee is given in Appendix F, and is offered as information and for discussion.

9. On the subject of Methods of Roadway Cross-Sectioning the Committee's report is given in Appendix G and is offered as information and for discussion.

10. On the subject of Heaving Track, the Committee's report is given in Appendix H, and is submitted as information and for discussion.

11. No information was called for by the Special Committee on Clearances during the year and, therefore, there is nothing to be reported upon under this subject.

Respectfully submitted,

THE COMMITTEE ON ROADWAY,

C. W. BALDRIDGE, *Chairman.*

Appendix A

(1) REVISION OF MANUAL

M. M. Backus, Chairman, Sub-Committee; H. B. Barry, W. A. Murray, J. A. Noble, W. M. Ray, E. M. Smith.

(a) In the revision of the Manual made in 1926—specifications covering "overhaul" were omitted. Some criticism has been made on account of this omission. To decide on the advisability of working up new specifications, a questionnaire has been sent to Class I Railroads of the United States and Canada. Up to October 28th, 33 railroads, a total of 133,173 miles, reported in favor of including in the Manual specifications covering "overhaul"; 25 railroads, comprising a total of 50,197 miles, stated saw no necessity for putting specifications in the Manual, and 4 railroads, comprising a total of 1696 miles, replied stating that they did not have "overhaul" clauses in their contract, but made no statement as to whether "overhaul" specifications should be included in the Manual or not. Recommendations are therefore made that this subject be included for study for following year.

(b) On page 28—Section 5—1929 Manual under "Slopes" the term ordinary earth is used. On page 30, Section 17, under "Classification" the term common excavation is used.

Suggestion is made that the term "common excavation" be used on page 28, Section 5, instead of ordinary earth, and the reading will then be—

Excavations:	Common Excavation	...One and one-half to one
	Loose Rock	............One-half to one
	Solid Rock	.............One quarter to one

(c) Suggested that the words "except that the use of salt for snow and ice removal from station platforms, near electrified tracks and from switches in electrified territory should not be permitted" follow Section 13 on page 74 under "Methods of Snow Removal," which reads—"Salt should be used on switches only during that portion of the winter when the snow melts in daytime and freezes at night."

(d) Suggested that the words "Definition of Soft Spot"—soft spots are small areas in excavation or embankment, or the sub-soil under an embankment, saturated with water and having a relatively small supporting power" appearing under Soft Spots, page 50, 1929 Manual be omitted in the interest of brevity as the same definition appears on page 23 under definitions.

(e) Suggested that the words "Borrow (noun)—material removed from a borrow pit," appearing on page 25 under "Grading," be omitted as there is another and better definition appearing on page 23 under definitions.

(f) The following specifications covering the manufacture of concrete fence posts and drawn up in collaboration with the Railways Bureau of the Portland Cement Association. are submitted for substitution of the specifications appearing on pages 68-69-70-71—1929 Manual:

SPECIFICATIONS FOR CONCRETE FENCE POSTS

(I) Materials

Cement, aggregate, water and metal reinforcement shall conform as to quality to the specifications for concrete of the A.R.E.A. as given under the subject "Masonry," except that the maximum size of coarse aggregate shall be not more than ¾ of the distance from reinforcement to outside of posts. Reinforcement shall be in the form of round or square bars, preferably deformed, or steel wires. Crimped, stranded or flat reinforcing shall not be used. When choice can be made between sizes of reinforcement it is better to use the larger number of smaller bars.

(II) Proportioning and Mixing

Proportioning and mixing concrete shall be in accordance with the specifications of the A.R.E.A. for concrete as given under the subject "Masonry" with the exception that the compressive strength of concrete shall vary with the distance from reinforcement to outside of posts as follows:

Edge Distance	*Comp. Strength at 28 Days*	*Water per Sack of Cement*
¾"	3500 lb.	5 gallons
½"	4000 lb.	4½ gallons
⅜"	4500 lb.	4 gallons

(III) Manufacture

Molds shall be substantial, true to plan and preferably of metal. They should be clean and coated with non-staining mineral oil or other approved material.

Placing Reinforcing

The reinforcing shall be securely held in position during the placing and setting of concrete. Metal spacers that would cause distinct lines of cleavage shall not be used.

Compacting

Concrete shall be thoroughly compacted into the molds and around the reinforcing. This is best accomplished by high frequency vibration of the molds.

Finish

All posts shall have a clean, smooth finish. If any pockets or holes are discovered upon removal from the molds, they shall be immediately filled with a mixture of one part cement to two parts fine aggregate. Pockets or holes more than ½ inch in depth or more than ½ inch in diameter, or any exposure of the reinforcing shall cause the rejection of the post.

Curing

Curing shall start within eight hours after molding and shall continue for the following periods of time:

Moist curing, kept damp 10 days at moderate temperature.
Steam curing, live steam, 2 days at temperature of 100 degrees.
High pressure steam curing, 6 hours at 100 lb. steam pressure.

Inspection

All materials and all processes of manufacture shall be subject to inspection and approval at all times. Free access shall be provided for all authorized inspectors to all parts of the plant in which the posts or the materials are made, stored or prepared.

Tests

Posts should be carefully made so as to secure a uniform strength in substantially all posts, and this strength should usually be such that the post will withstand a force of not less than 180 lb. at right angles to the axis of the post, the post acting as a cantilever, beam supported at the ground line and the force being applied 60 in. above the ground line.

Patents

The manufacturer shall pay all royalties for the use of patented designs or devices or forms of construction and protect the Railway Company from all claims of infringements or liability for the use of such patents.

(g) Suggested that when Manual is rewritten the material covering specifications for metal fence posts, appearing on pages 57 and 58 under "Roadway," be transferred to a position immediately preceding the material on concrete fence posts appearing under Signs, Fences and Crossings on page 68.

Conclusions

It is recommended that subject appearing under paragraph (a) be continued.

It is recommended that suggestions made in paragraphs (b) and (c) be accepted for inclusion in the Manual.

It is recommended that paragraphs (d) and (e) be withdrawn from the Manual.

Appendix B

(2) ROADBED DRAINAGE

G. S. Fanning, Chairman, Sub-Committee; E. J. Bayer, W. G. Brown, J. F. Dobson, G. E. Ladd, E. R. Lewis, E. C. Oyler, W. M. Ray, H. M. Swope.

INTRODUCTION

Inasmuch as this subject was reassigned to the Roadway Committee, principally because of the criticisms made on the floor at the 1929 convention that this subject was not adequately covered in the Manual, this Sub-Committee has undertaken a complete review and amplification of such material.

The necessity for some special provision for roadbed drainage has been recognized in specifications for the formation of the roadbed from the time of the earliest construction in America (see A.R.E.A. Proceedings, Vol. IV, 1903, page 10, for Baltimore & Ohio Railroad Specifications of 1828) to the present. Of necessity specifications are quite general in word-

ing, leaving details to the judgment of the Engineer, as will be noted from the following quotations from the present A.R.E.A. Specifications:

"Intercepting ditches, *when ordered,* shall be made at the top of the slopes of all cuttings where the ground falls toward the top of the slopes."

"Ditches shall be formed at the bottom of the slopes in cuttings according to cross-sections shown upon the plans, or *such modifications thereof as may be directed.*"

"Subdrains of tile shall be constructed of the size and location *as directed* and to the depth and grade *established* for them."

Too much is left to orders and direction which are never given. Innumerable instances are noticeable in which much expenditure after construction might have been avoided if the drainage features had not been neglected, either through false economy or ignorance.

The following report is offered as a specific guide towards the prevention and cure of the conditions arising from the neglect of roadbed drainage

ROADBED DRAINAGE

Outline

Scope.
Importance.
Recommended Practice:
- A. On Location.
- B. On Construction:
  - I Surface Drainage:
    - Intercepting ditches for cuts.
    - Intercepting ditches for fills
    - Side ditches.
  - II. Sub-surface Drainage:
    - Pipe drains.
    - French drains.
  - III. Special problems during construction:
    - Long cuts.
    - Multiple tracks.
    - Yards.
    - Station grounds.
- C. On Maintenance:
  - I. Maintenance of ditches.
  - II. Maintenance of drains.
  - III. Special problems of maintenance:
    - Soft spots.
    - Slides.

Scope

This subject has to do with the artificial surface and sub-surface drainage of the cuts and fills which make up the roadbed, as distinguished from the drainage of the natural surface of the ground by natural waterways.

Importance

Adequate drainage of railroad roadbeds is a matter of major importance to every railroad company, more particularly so in these times of almost universal demand for high speed in transportation. High speed operation of trains depends primarily upon good track. It is axiomatic that excellence of track depends dierctly upon stability of the roadbed. It is quite as evident that stability of roadbed depends on minimizing moisture and that minimum moisture depends upon adequate drainage.

It may be said, therefore, that a fundamental principle of railroad location, construction and maintenance is to keep the roadbed dry.

RECOMMENDED PRACTICE

(A) Location

Location Considerations

Due consideration to probable roadbed drainage conditions should be given by locating engineers in selecting locations, particularly to avoiding, where it is economically practicable to do so,

(1) Cuts in wet springy ground.
(2) Long cuts on low grade lines.
(3) Fills across swampy ground which cannot readily be drained.

(B) Construction

(I) Surface Drainage

Construction

1. Every reasonable means should be employed to intercept the natural course of water from outside sources that would otherwise reach the roadbed.

Intercepting Ditches for Cuts

2. Through ground sloping transversely, intercepting ditches should be made on the upper side of all cuts where ditches may be opened without becoming the proximate cause of slides to the roadbed.

The size of the ditch should be determined in each instance by hydraulic calculations based on the quantity of water to be carried. The minimum ditch should be one foot deep and three feet wide on the bottom, with slopes to suit the soil.

The minimum grade for intercepting ditches should of 0.3 per cent. If the grade of any ditch necessarily be so great as to produce eroding velocities, paving will be necessary.

The distance of the top of slope of the ditch from the top of the slope of the cut should be sufficient (not less than 10 ft.) to prevent seepage of water from the ditch through the ground to the slope of the cut. Where the soil is of such a permeable nature as to make this impossible, the intercepting ditch should be tightly boxed or paved.

As far as practicable intercepting ditches should be made in advance of excavating the cuts. The material excavated from the ditch should be deposited on the side of the ditch towards the cut. The slope of the waste bank from its summit toward the ditch should be as long as is feasible. In crossing light depressions in the hillsides, levees may be constructed and the hillside filled in above the levee so as to bring its surface up to the grade of the ditch. The top surface of this fill should preferably be of puddled clay.

Intercepting Ditches for Fills

3. Intercepting ditches should be constructed along the toes of the slopes of such embankments as rest upon soils which may become unstable if saturated, for the purpose of diverting from the surface upon which the embankment rests the water flowing towards the embankment. Such ditches should be of as great depth as economy of construction warrants so as to aid in drying the unstable soil and in removing such water as will reach the ditch by percolation through the embankment.

The distance between the toe of the embankment and the top of slope of the ditch should be sufficient (not less than 10 ft.) to avoid any danger of causing slides in the embankment.

In flat country, where the embankment has been made from side borrow, the intercepting ditch should be located near the right of way line and should be deep enough to drain the borrow pits. In all cases the area between the embankment and the ditch should be graded so as to slope towards the ditch to prevent water standing in pockets along the toe of the embankment.

The data given above for dimensions and grades of intercepting ditches for cuts applies also for ditches at the toes of embankments.

Side Ditches

4. Side ditches should be constructed at the foot of the slopes in cuts through all classes of material, for the dual purpose of draining the roadbed and protecting it by intercepting and carrying off the accumulation of surface water from the slopes due to rainfall and seepage. These ditches should be kept well below the subgrade.

They should be of sufficient capacity, determined by hydraulic calculations, to take off readily the water from the heaviest rainstorm and of such shape as can most easily be cleaned. The minimum side ditch should be constructed and maintained on a true grade, not less than 0 3 per cent with ample pitch at the outlet.

Conclusion

The present report covers the subjects in the outline down through Surface Drainage on Construction. The material included in the Recommended Practice is taken almost entirely from A.R.E.A. Proceedings. The Committee recommends the adoption of the report beginning at the Outline for publication in the Manual, replacing the following existing material:

Page 49—Drainage of Large Cuts—Paragraph (1).
Page 41—Surface and Sub-Surface Drainage—Paragraphs (1), (2), (3) and (4).

The Sub-Committee has accumulated considerable material to continue this report in accordance with the outline, but it awaiting certain unpublished information with respect to the use of perforated corrugated iron pipe which has been offered to it for consideration.

The Committee recommends that the subject "Roadbed Drainage" be continued until completed in accordance with the Outline.

Appendix C

(3) INFLUENCES AFFECTING THE LIFE OF FENCE WIRE AND METHODS FOR PREVENTING ITS CORROSION

W. C. Pruett, Chairman, Sub-Committee; T. A. Burgess, L. J. Drumeller, J. S. Goodman, H. W. Legro, W. F. Monahan, H. M. Swope, Thomas Walker.

The Committee has assembled some data on this subject but at present can report information only. Reference is made to the studies on this subject as appearing on page 607 of the 1925 Proceedings and page 425 of the 1926 Proceedings. In following up the information contained in these former reports it is found, as has been stated, that the influences affecting the life of fence wire are: its nearness to the coast, various mines, and industrial plants; locations in swamps and wooded country; frequent burning of vegetation under and about the wire, heavy snows, abuse by trespassers, and damage by live stock. Information has been secured of several tests that have been and are now being conducted to determine the best methods of overcoming these adverse influences.

A test in close proximity to the Gulf made with different types of wire a few years ago, on the Gulf and Interstate Railroads, a part of the Santa Fe System, which extends from Bolivar's Point to Beaumont, Texas,

shows the following results: An ordinary iron barbed wire, extra heavy galvanized, which tested four one-minute immersions in copper sulphate solution of standard strength, was installed. An inspection four and one-half months after erection disclosed on the bottom strand of wire practically all of the barbs rusted to such an extent that the galvanized coating in a number of places was entirely gone and deterioration by rust very great.

A copper-bearing steel barbed wire with ordinary galvanizing was installed and upon inspection four years and seven months after erection, showed very little deterioration except around the barbs where there was some signs of rust but not to a great degree. An inspection of this wire six years and seven months after erection showed a portion of the wire having been changed out, but some yet in service with an estimated additional life of two to three years.

Black barbed wire leadized was installed and inspection six months after erection showed it to be badly rusted and weak in several places.

An ordinary galvanized barbed wire painted with a good grade of paint was installed and upon inspection seven months after erection was found to be completely covered with salt spray around the barbs and twists of the wire; the paint was eaten off and pockets formed, causing the wire to wear out faster than the galvanized unpainted wire at the same location.

Another test conducted by one wire manufacturer in conjunction with the C. F. Burgess Laboratories, Inc., of Madison, Wis., was installed near Galveston, Texas, between February 13 and 15, 1928, and was concluded on January 3, 1930. In this test nine different makes of barbed wire and thirty-nine different makes and types of woven wire were installed. Actual laboratory tests of pieces of wire taken from these samples before being applied in the test, develops that the zinc coating on this wire averaged from .08 oz. to 2.11 oz. of coating per square foot of metal. The barbed wire with a coating of from .22 oz. to .36 oz. per square foot of metal was found to be in very poor condition; whereas, barbed wire with coating averaging from .50 to .87 oz. per square foot of metal was found to be in very good condition. The woven wire with a coating of from .08 to .48 oz. per square foot of metal was in poor condition, while the woven wire with a coating of .87 to 2.11 oz. per square foot of metal was found, in most cases, to be in excellent condition.

In this test there was used also, wire which in addition to being galvanized was of a copper-bearing steel. This copper-bearing steel wire with only a light coating of galvanizing made a much better showing than the non-copper-bearing wire equipped with a heavy zinc coating. On the non-copper-bearing wire, it was observed that as soon as the galvanizing had been corroded from the steel, that the steel began rusting at a very rapid rate as was evidenced by loose, thick, flaky, rust and deep pitting. A point of weakness in all the woven wire was found in the stays. This is possibly due to the practice of applying a lesser amount of zinc coating to the stay wire in order to prevent its flaking while being wrapped around the line wire. The rusting of this stay wire, especially at the wrap caused the line wire to corrode very rapidly at that point. The same condition was evident at the barbs of barbed wire.

The development during the past few years of copper-bearing steel which is being used successfully in the manufacture of wire, should prove of much benefit in preventing the destruction of wire through rust, even

after the zinc coating may have corroded. This was clearly indicated by the test conducted by C. F. Burgess Laboratories at Galveston. The corrosion resisting steel even with a lesser coating of zinc withstood the salt atmosphere much better than the heavy zinc coated non-copper-bearing steel.

The process of galvannealing, referred to on page 607 of the 1925 Proceedings, is reported to have shown, both by field test and by laboratory test, to withstand corrosion much better than the ordinary galvanizing. The treatment through the annealing furnace partially remelts the zinc coating and causes to be dissolved therein an added amount of iron from the steel base forming a three-layer instead of a two-layer structure, which is clearly shown in the photomicrographs of a sample that had been etched with 1 per cent hydrochloric acid for one minute. This forming of an iron-zinc alloy by the heat treatment, should produce a stronger bond between the coating and the base, that in addition to furnishing longer galvanic protection, will also provide a better bending quality.

A field test report on wire and fencing, as mentioned on page 425 of the 1926 Proceedings to be conducted by the American Society for Testing Materials under the direction of the Chairman of Test Committee on Corrosion of Iron and Steel, Mr. J. H. Gibboney, Chief Chemist of the Norfolk & Western Railway, has been delayed due to the unsatisfactory condition of samples collected, brought about by faulty conditions while holding the material in storage. The Committee is informed that new material is being collected and specimens will be placed on test racks within the coming year and that we may anticipate some information from this test.

There has just recently appeared on the market a wire which consists of copper being welded to the core of steel made by the molten welding process. This wire has the appearance of possessing excellent corrosion resisting properties. The Committee has been unable to find where any installation has been made of this wire for test purposes. It is hoped that more definite information may be obtained on the service of this type of wire for future report.

Conclusions

1. Zinc is the most suitable protective coating for wire.
2. The protection afforded by galvanizing is determined by the amount of zinc coating per square foot of surface treated.
3. The galvanizing on barbs of barbed wire and the stays and wraps of woven wire is usually the first to fail.
4. The use of corrosion resisting steel for the base in wire is almost equal—if not better—than a good coating of galvanizing.
5. The annealing treatment produces an iron-zinc alloy which has proven by tests to provide a longer life to coating with the resultant longer period of galvanizing protection to the steel base, against ordinary corrosion.
6. Damaging effect to the zinc coating on wire, resulting from the burning of vegetation under and about the wire, is very pronounced.

Recommendations

This report is submitted as information only, and it is recommended that this subject be reassigned for the succeeding year in order that further study may be made on the tests now under way, and that further information may be obtained by actual uses.

Appendix D

(4) PERMANENT ROADBED

A. E. Botts, Chairman, Sub-Committee; Paul Chipman, J. F. Dobson, T. M. Pittman, W. M. Ray, E. M. Smith.

The study of permanent roadbed construction through this year has failed to locate any new tests being started.

Various types of permanent roadbed construction are used by different railroads in tunnels and terminals but the majority of these have been in detail brought to the attention of the Association.

The old and new concrete roadbed installation of the Pere Marquette Railroad near Beech, Michigan, are reported on by Mr. Paul Chipman as of September 4, 1930, as follows:

First Installation

This was placed in operation on December 19, 1926. There has been no change in the condition of the roadbed itself since my report of a year ago. However, the south rail was changed out on July 11, 1930. This rail rests directly on the concrete, and the track was beginning to get rough, on account of batter at the joints near the east end of the test section. Traffic pushes the rail west, but at the west end it is held by the rail on the new section. For this reason the joints at the east end have always been more open than they should be.

The rail taken out was new 90-pound rail when laid in December, 1926, and was replaced with selected 90-pound relay rail. A series of careful measurements of batter were made on both rails shortly after this rail was changed and readings will be taken at intervals in order to secure more accurate data in this respect. On the west half of the slab, where the joints are tight, the batter is comparatively small. The behavior of this rail clearly indicates that the length of joint gap has a marked effect on the amount of batter. It also clearly indicates the advantage of a thin layer of some more compressible material between the rail and the concrete.

On account of the arrangement of the rail clips, fish plates were used at the joints. It was thought that these would serve as well as angle bars, as the rail is continuously supported. Probably no small share of the excessive batter at these wide joints was due to this fact. Five of the plates developed cracks where they were nicked by the rail head, indicating a considerable stress in transferring the rail wave through the joint. These all occurred at joints where the opening was excessive.

The cost of maintaining this one-quarter mile section during the past year was as follows:

October,	1929—Bonding rail	$ 37.70
December,	1929—Renew 27 bolts	28.12
	Helping Signal Dept.	28.74
	Change out rail	9.87
May,	1930—Change 3 rails	28.64
July,	1930—Change 1287 ft. rail	173.01
		$306.08

Three of these items, totaling $21.52 cover changing out rail and two items totaling $66.44 relate to signal work made necessary by a design which did not adequately provide for insulation. The remaining item of $28.12 renewing bolts, was also the result of a faulty design, the bolts being too light for the stresses to which they are subjected at points where there is a slight depression in the rail seat.

It has been realized for some time that the batter on this rail was more than normal, but information was desired as to the relative batter of a rail

resting directly on the concrete and one where a thin cushion is used. The cost of its replacement should therefore be charged to experimentation rather than maintenance, when comparison is made with ordinary track, as its renewal at this time could have been avoided by interposing a cushion, using angle bars instead of fish plates, and keeping the joints tight. Approximately 18,000,000 gross tons had passed over this rail before it was removed.

On the nearby one-quarter mile section of ordinary track, on which comparison has heretofore been made, the cost of maintenance was as follows:

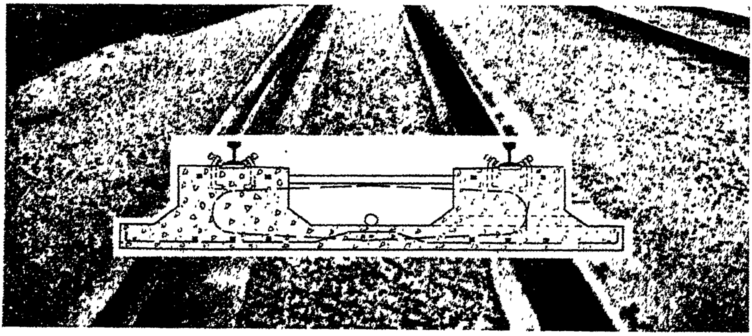
August,	1929—Surfacing	$ 8.83
October,	1929—Surfacing	11.28
February,	1930—Tightening bolts and spikes	14.62
March,	1930—Surfacing	19.92
April,	1930—61 ties	100.65
July,	1930—Scuffing weeds	12.49
		$167.79

New Installation

This was placed in operation September 20, 1929. It is in the same condition as when installed, except that at two of the joints spalling of the surface, similar to that found at some of the joints on the old installation, has occurred. This is probably due to poor material used in finishing at these points. No cracks have appeared.

The method used for seating and fastening the rail has been quite satisfactory. The board under the rail shows no indication of wear. When operation first began, the holding down bolts showed a tendency to become loose, on account of wear between the rounded end of the bolt and the small casting which rests on the rail. After a few weeks these surfaces became adjusted, after which it was only necessary, to tighten the bolts at long intervals. There has been practically no creeping of the rail since the first few days of operation, and very little batter. Most of the joints are tight at a temperature of 60 degrees or more. An increase of temperature merely puts the rail under a compressive stress, which is transmitted to the rail support through the fastenings. This is apparently true to a certain extent in regard to contraction also, the tensile stress being transferred to the rail support in like manner. This indicates the probability that rail could be laid with close joints at almost any temperature above the freezing point, and thus prevent a large part of the batter which would ordinarily occur, or welded and thus prevent it entirely.

There has been no expense for maintenance on the new installation, except for a few hours tightening bolts, most of which was done in the first month of operation.



Concrete Roadbed, Pere Marquette Railway

Appendix E

(5) GOOD GRADING PRACTICE

H. T. Livingston, Chairman, Sub-Committee; E. J. Bayer, J. D. Elder. J. L. Fergus, J. A. Given, David Hillman, E. R. Lewis, H. M. Swope. O. H. Wainscott.

"Grading," as termed by the Interstate Commerce Commission classification, includes cost of clearing, grubbing, excavating, grading of roadbed, and the installation of protection for an embankment, as well as the expense of changing the courses of streams to improve drainage, and to avoid the necessity of constructing bridges. For discussion, the Committee has considered the general subject of "Excavations and Embankments" only. Each project of construction presents certain limitations that make it impossible to specify, empirically, the type of equipment to use. Most of the railroads have certain work equipment which they use for maintenance purposes, or when a Contractor's equipment will interfere with train operation, but for work, not immediately adjacent to existing tracks, it is generally more practicable to contract major projects.

The Contractor receives a proposal, which describes the work to be done, and, in which, quantities are given approximately. Attached to the proposal is a set of specifications and, possibly, a plan and profile. The Contractor should visit the site of the proposed work and inform himself on all of the local details of topography; soil; transportation facilities; availability of fuel, water and sustenance for men and animals; average weather conditions; popularity of the project with local inhabitants; availability of local labor and local wage rates; and such other details as may apply. Theoretically, the Contractor bids on the project, having a definite plan for construction; however, bids are also influenced by competition and insufficient time to give adequate study. General Contractors have at all times a considerable plant that may consist of nearly every type of excavating machine, and yet they may be forced to purchase or rent entirely new or different equipment if a profit is to be made, or a loss avoided.

The successful bidder on a project signs a contract wherein he agrees to complete, by a certain date, a given project. Types of contracts vary, in that bonuses are given for earlier completions, and penalties inflicted for failure to complete. These variations in form do not change the fact that a definite time has been assigned for accomplishment, and in accordance with fixed rules described in the specifications. The contract, specifications, plan and locale become the determining factors that govern the types of equipment that should be used.

Railroads demand speed in completion of most work, for three principal reasons; namely, (1) Necessity to make the savings in operation which the project promises; (2) Reduce the interest on investment accruing during the period of construction; (3) Reduce the period of construction, where construction work affects an operated line and increases operating costs.

This demand for speed in construction tends to produce a roadbed that will be subject to a longer period of solidification and subsidence; a condition that must be met by further care, study and increased expense

during construction. Most difficulty is experienced with new embankments, due to such causes as weak subsoil, sliding excavated material, quantities placed too dry in fills, superimposition of heavy stone on light material, and construction of embankments from trestles.

Where weak top or subsoils occur under high embankments, some railroads excavate the original ground and haul in suitable material for a base. When this plan is not feasible, a mat of logs may be laid and the fill placed thereon. The subject of slides cannot be discussed here, except in so far as they may occur during construction. They are generally overcome by constructing a bench, or berm at the base of the fill Material should not be placed in an embankment too dry, as it will "swell," and later settle below grade after a period of saturation with water. Many railroads, and some of the State Highway Commissions, now specify that embankments shall be treated by the addition of water as they are built, and that they shall be built in horizontal layers of from one to six feet in thickness and then compacted with 10 to 15 ton road rollers. One railroad specifies that when fills are cast in from the side with drag lines, the work shall be done in 2-foot lifts and each layer rolled with not less than a 10-ton road roller. When such requirements are demanded, Engineers should not permit the use of caterpillar equipment as a substitute, as such equipment has very little weight per unit of area.

When material is placed in embankments by hydraulic methods, the material is usually sand, and results have shown very few failures, and little settlement in the completed work. The tendency to "wash" can be overcome by riprapping, paving, or sodding. Generally, in excavating a cut, the rock is found in the lower portion, and is removed after the earth has been stripped. To overcome the placing of this heavy material on top of an earth fill, or earth core, the quantity of the earth coming from the top of the cut can be computed and the fill completed to full section for the distance that there is available material. The excavated rock should then be placed as a complete section, in a similar way. If steam shovel and trestle is used, it would be desirable to make the center portion with earth, and the ends of the fill with rock, and the reverse arrangement if no trestle is used. It is thought that an embankment having its extremities built of rock, would be ideal construction, as the loose stone would serve as large "French drains," and prevent water from reaching the fill from adjacent cuts.

A complete preparation of the site of operation is desirable, before the movement of the major quantities is begun. On side hill embankment location, the original ground should not have slopes in excess of one foot vertical to ten feet horizontal, at right angles to the centerline of the embankment. When slopes are in excess of the above, the ground should be "stepped" or scarified to insure bond with the new material. Surface ditches should be constructed to protect cuts, their distance from the cut to be governed by depth of cut and character of the soil. Berms at the base of embankments should be ample to prevent breaking under the weight of the embankment. Slopes in cuts and on fills should not exceed the angle of repose of the material used.

The present trend in railroad, as well as highway, grading practice is toward the use of mobile equipment, with few operators. The question of

"haul" has been almost eliminated, and material is now carried as much as three miles. This does not mean that it can be hauled for nothing, but rather that, in balancing excavation and embankment quantities, it is now possible to use material economically, that a few years ago would have been wasted, or additional curvature introduced to avoid excessive quantities. To definitely state the economic distance which each type of equipment will serve is impossible. Topography, soil and weather govern, and a study of each project would be necessary to decide.

Many projects lend themselves to the economic use of different types of equipment within the same area, where quantities are unusually large. One railroad is constructing a change of line across a river, where the grade line is about 60 feet above water. The lower portion of the embankment is being built of good sand pumped from the river. The upper portion of the fill is "cored in" by the use of steam shovel equipment and narrow gage cars, which dump from a trestle built on the sand base. Upon completion of the earth core, the fill is to be completed by use of "cat" wagons.

A resumé of various types of equipment now in use will include: (a) *Steam or gas shovels,* with either standard or narrow gage dump cars, handled with steam, gasoline, electric, or air locomotives. (b) *Draglines:* These may be operated by steam, gasoline or fuel oil, and may cast material directly into a fill or waste it from a cut, or may be used to load haul-off equipment. (c) *Ditching machines:* These are variously powered, but are generally gasoline operated. These machines are used principally for trenching for sewer, water, tile lines, etc. (d) *Clam Shells and Orange Peels:* Variously powered and generally used where excavated material is under water, in cofferdams, or in piles, or when material cannot be handled readily with steam or gas shovel. They are especially adaptable where material to be excavated is to be moved only within the radius of the boom. (e) *Hydraulic Pumps:* This type of equipment is adaptable for use in construction of embankments when good sand is available within a reasonable distance from the embankment, and there is an unlimited supply of water available. This has proved to be a very economical method, where the size of quantities has warranted the installation of the plant and pipe lines.

Other types of equipment in use are principally the units that complete the plant for haul-off and finishing operations. They include dump cars, plows, spreaders, "cat" wagons, bull dozers, scrapers or road graders, scarifiers, road rollers, trucks, caterpillar trucks, etc. Gasoline engine powered equipment seems to find favor with most Contractors, especially when poor highways are the only means of transportation to the site of the work. "Caterpillar" wagons and trucks are practically a necessity when "on time" completion is required, and where the material to be handled is unusually wet. A type of "cat" wagon that will dump in any direction is now on the market. There are trucks that substitute the rear wheels with caterpillars. On this newer type of equipment, a Contractor should carefully estimate his overhead expense, especially depreciation, repairs and interest. Much of the equipment now on the market has not been tried for a long enough period to determine its average life. Diesel engine driven equipment seems to have found favor with many Contractors, but there have been enough breakdowns to warrant a close study by manufacturers to prevent their present high frequency. A breakdown, for but a few shifts

duration, may mean failure for a Contractor, even though the actual cost of such failure is assumed by the Manufacturer.

This report does not attempt to cover specifications for grading, nor to specify equipment to be used, but merely mentions and partially lists types of equipment and methods now in use. Any project must be given study, and the solution sought, that will circumvent the difficulties, and accomplish the desired results, and show a reasonable profit to the Company that performs the work.

Appendix F

(8) THE USE OF HIGHWAY CROSSING PLANK AND SUBSTITUTES

F. W. Hillman, Chairman, Sub-Committee; J. A. Given, E. J. Bayer, J. S. Goodman, R. L. Kittredge, W. F. Monahan, P. T. Simons.

The subject as assigned to the Committee is Study and Report on the Use of Highway Crossing Planks and Substitutes, collaborating with Committee V—Track and Committee IX—Grade Crossings.

As stated in last year's report, the time element must be determined more definitely before cost of installing the more expensive and seemingly more permanent types of highway crossing materials can be justified. In connection with this the cost of maintaining substitute materials must be considered. Then, too, as most of the so-called permanent types, to justify their use, must last longer than the time that track can be left without repairs, the ease and cost with which they can be removed and replaced must be taken into account. Also, consideration should be given to the possibility of salvaging the materials and placing elsewhere if crossing is eliminated.

As is generally known, the railway cost accounting system does not lend itself readily to determining this very essential information and it can be obtained only by special observation and cost keeping data. Very few, if any, railways appear to have gone this far in their study of Substitutes for Highway Crossing Plank. Many have kept accurate costs of installation, but few segregate cost of track work from cost of installing the crossing materials, which is very essential for a proper comparison.

A worthwhile test has been recently started by the Chicago, Milwaukee, St. Paul & Pacific Railway in the Chicago, Illinois, District. A report from G. T. Jackson, Special Engineer of this Railway, on this installation follows:

"During the past two years the Chicago, Milwaukee, St. Paul and Pacific Railroad has installed various types of street and highway crossings in the Chicago District to see if an economical crossing could be developed.

"Two years ago we installed a rail type crossing where our main tracks cross River Road which is a high speed highway carrying truck, bus and auto traffic.

"Drainage conditions were ideal in that our tracks are on an embankment 4 feet high and made of a good grade of gravel. The crossing is only 200 feet from the Des Plaines River and well above water level so that surface and subsoil drainage conditions are good.

"The track structure consists of 130-lb. rail on two tracks and 100-lb. rail on the other two. Sawed treated oak ties 7" x 9" x 8'6" were used. The ballast consists of 8 inches of crushed limestone supported by the compact gravel fill. All joints in the running rails were welded.

"Nine 65-pound rails were used inside the running rails and three outside. White oak shims 8 inches wide spiked to the ties were used to bring the 65-pound rail level with the running rail.

"Concrete slabs 12 inches thick were placed between the tracks with a ½-inch expansion joint at the end of the ties. The tracks including the 65-pound rails were concreted from the bottom of the ties to the top of the running rails.

"The crossing so far rides good both on the highway and on the railroad and is in the same condition as when placed. A crossing of this type can only be used where drainage conditions are such that the track will not require attention and it may be that some other type of crossing will prove as good and at the same time provide for easier track maintenance.

"During the past year in the Union Station District in Chicago we have installed 7 armored, 6 unarmored concrete slab crossings, 4 malleable and 2 steel crossings each 50 feet wide. These crossings are at points where streets cross our team track yard. The traffic consists of trucks and heavy loads from Gantry Cranes in the District. None of the crossings have been in long enough to form an opinion as to their relative economy or riding qualities.

"On all of the crossings the construction is the same. Tile drains were installed between the tracks and about 4 ft. below base of rail. Ninety-pound rail with welded joints, sawed, treated, plated oak ties 7" x 9" x 8'6" with 8 inches of gravel ballast were used. The subgrade consisted of 12 to 18 inches of old cinders and gravel on a wet clay subsoil.

"After about six months the concrete slabs showed some signs of wear and to protect the slabs a coating of asphalt ¼ to ½ inch thick was applied. This seems to be giving good results, but has yet to stand the winter test, which may cause the asphalt to peel off.

"The metal crossings so far shows no signs of failure. At all the crossings there are 12-inch concrete slabs between the tracks and concrete pavement outside. As was expected after inspecting a number of crossings the joint between the concrete pavement and the crossing is one of the difficult things to provide with any of the crossings. The best result so far have been obtained by placing an offset in the concrete each side of the crossing 2 inches by 6 inches. The face of the concrete at the bottom being 1 inch from the end of the tie. This gives a space 3 inches by 6 inches between the crossing and the pavement and extends from the top of the tie to the surface of the pavement. An oak strip 3 inches by 4 inches was placed in the bottom of this space and a layer of asphalt and stone 2 inches by 3 inches was placed on top to make the joint between the crossing and pavement.

"In this same district we have standard plank crossings made of 4-inch oak on the same track structure. We have placed an asphalt wearing surface ½ inch thick on some of these crossings to see what the effect will be.

"After the track has been put in shape to receive the crossing the cost for a single track crossing has been as follows:

4-inch oak plank........................	$ 5.00 track foot
Concrete slabs	10.00 track foot
Metal	20.00 track foot
Rail type	12.00 track foot

"It is too soon to form an opinion as to the merits of the various types of crossings; with the wide difference in cost there must be corresponding savings in maintenance or more satisfactory service.

"We hope in the next 5 years to begin to form an opinion as to the relative meirts of the various crossings now in use and some other types we have in mind."

A report from the Chicago, Burlington & Quincy Railroad states that about 1920 or 1921 a steel plate and angle crossing was placed on Fifth Street, Burlington, Iowa. on a sidetrack crossing of a fairly heavy traffic street. This crossing has required practically no maintenance since installation, has been easily removed and replaced when necessary to renew ties and surface track. There is now some evidence of corrosion which, however, is not as yet serious.

There seems to be considerable question as to whether concrete slabs or plank should be armoured or unarmoured. The armoured slab consisting of steel protection around wearing surface edge of concrete slab is contended to obviate the breaking off of corners or edges. In the unarmoured slab attempt is made to overcome this by chamfering the edges. Experience from the old concrete highway in which steel plates were used at construction or expansion joints indicates that the concrete surface wears down in time and leaves steel plate projecting, resulting in uncomfortable bumping of vehicles.

The Chicago, Cleveland, Cincinnati & St. Louis Railway has used concrete slabs extensively with satisfactory results and favor the armoured slab. Their installation costs are from $8 to $10 per linear foot of track.

The Chicago, Milwaukee, St. Paul & Pacific Railway installed unarmoured slabs in some crossings at Madison, Wisconsin, about five years ago. The edges were chamfered and so far they do not show any objectionable chipping.

The Erie Railroad has made a number of installations of armoured concrete slabs in its large team yard in Chicago and other places from which useful data should be obtained.

It is evident from reports that a first-class quality of concrete should be used and there is some thought that what failures have occurred have been due quite largely to use of poor concrete. Then, too, care should be taken to have uniform bearing on ties spaced uniformly and so that ends of slabs will bear upon a tie.

The Southern Railway System reports very satisfactory results with the rail type crossing. They have used this type for a number of years and have many installations in Indiana, Illinois and Kentucky where crossed by high speed improved highways. They are used in automatic signal and train control districts and in such instances an insulated wooden strip is used in place of the middle rail. Where crossings are extremely wide the rails are cut in center of crossing so that one side can be taken up and repaired without completely tying up highway traffic. Care is taken to put track in first class condition, renewing ties and ballast before constructing crossing so that track does not have to be touched for a long time. The cost and convenience of this type of crossing results in opinion that it is the cheapest to use.

Recent designs of rail type crossings take care to flare the end of first rail inside of running rail the same as on standard guard rail construction, something which was not done on earlier installations.

One railroad recently installed a number of crossings of bituminous material across a track laid on a newly constructed embankment. Within a comparatively short time track had settled so that crossings had to be removed so as to surface track. Decision was made to use wooden plank

until track has settled sufficiently and bituminous materials used only when embankment is well solidified.

One type of crossing tried consists of laying a layer of plank on ties parallel to running rails and another layer of planks laid on top crosswise or parallel to the highway traffic with sections of cast iron flangeways next to the rail. One railway reports this type not satisfactory from a track maintenance viewpoint.

Appendix G

(9) METHODS OF ROADWAY CROSS-SECTIONING CALCULATIONS AND MEASUREMENTS

J Vawter, Chairman, Sub-Committee; H. B. Barry, T. A. Burgess, L. J Drumeller, J. L. Fergus, T. M. Pittman.

The Committee has made no extensive study of the subject nor searched for a number of different methods of calculations and measurements of cross-sections, but has only used the experience of some of its own members. The methods given are those that the Committee feels can be used with a small amount of labor and computations.

REGULAR SECTIONS

In field measurements for regular roadbed sections, the common method of recording cross-section notes is satisfactory and rapid. This consists of calculating the height of the level above the proposed subgrade, this value being called the grade rod. When the elevation of the level is below the subgrade, the grade rod has a negative value. If the rod reading at any point on the section is subtracted from the grade rod, the amount of cut or fill at that point is obtained. Positive values indicate cut and negative values fill. Typical notes for a cross-section for a fill are given below, the roadbed being 20 ft. in width. This section is shown in Fig. 1.

L		*C*		*R*	
$\frac{-7.4}{21.1}$	$\frac{-6.0}{11}$	$\frac{-5.2}{0}$	$\frac{-4.8}{6}$	$\frac{-5.0}{10}$	$\frac{-4.6}{16.9}$

This can be computed in a number of ways, either by calculating the areas of the various trapezoids individually or by using some of the shorter methods. There are a variety of favorite methods used by different field men, the method of approach being different in some as to whether it is a one-level, three-level, or some other number of readings at the section.

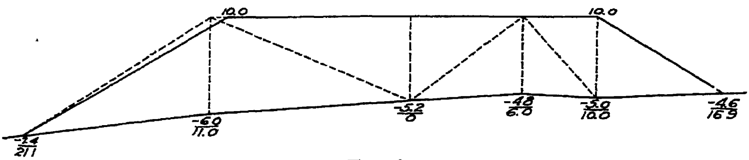


FIG. 1

The basic methods for calculating cross-section areas is to multiply the average of adjoining readings by the distance between them. This gives the area of the trapezoid between the subgrade and the original ground line. From the sum of these trapezoids must be subtracted the areas of the two triangles which have the extreme side readings for altitudes, the subgrade extended for the base, the side slope being the other side (see Fig. 1).

To illustrate:

$$\frac{7.4+6.0}{2}\times 10.1+\frac{6.0+5.2}{2}\times 11+\frac{5.2+4.8}{2}\times 6+\frac{4.8+5.0}{2}\times 4+$$

$$\frac{5.0+4.6}{2}\times 6.9-\frac{7.4\times 11.1}{2}-\frac{4.6\times 6.9}{2}=155.05 \text{ sq. ft.}$$

If desired the sum of the adjacent readings may be multiplied by the distance between them and the final sum divided by two.

This method is simple and advantageous for young field men to use, as they can readily understand the reason for each step in the computations.

The following method is applicable to any number of readings per section and is simple and direct. It appears in a variety of forms in field books, some of which involve applying certain algebraic signs to either numerator or denominator and using these signs in the computations. The first step is to add a reading of zero over one-half the roadbed on each side of the cross-section, the notes now reading,

$$\frac{0}{10}\quad \frac{-7.4}{21.1}\quad \frac{-6.0}{11}\quad \frac{-5.2}{0}\quad \frac{-4.8}{6}\quad \frac{-5.0}{10}\quad \frac{-4.6}{16.9}\quad \frac{0}{10}$$

In the method below, each numerator is multiplied by the distance between adjacent readings, these are added together and divided by two, the result being the area of the cross-section. In the section above, since 10 is less than 11 and is given as an outside distance, the difference between these two readings is necessarily -1.

To illustrate:

$$\tfrac{1}{2}\,(7.4\times(-1)+6\times 21.1+5.2\times 17+4.8\times 10+5\times 10.9+4.6\times 0)=155.05 \text{ sq. ft.}$$

By comparing the separate multiplications above with the triangles formed by the dotted lines in Fig. 1, it is seen that each multiplication, except the end ones, gives twice the area of two triangles, the amount of cut or fill being the common altitude of the two triangles. Only the double area of a single triangle is computed in the first and last multiplications of the equation. When the reading first inside of the slope stake is outside of the roadbed, the area of this triangle is negative; and when the reading is inside, the area is positive. This is shown on the left side of Fig. 1, where the base of the triangle outside of the embankment is -1 and its altitude is 7.4. The area of this triangle must be subtracted from the other areas, since it has been included in the other multiplications. Since double areas have been calculated, the final summation is divided by two so as to obtain the correct area.

For a three-level section such as the cut section below, the roadbed being 28 ft., the method is quite direct.

$$\frac{+6.4}{20.4} \qquad \frac{+7.0}{0} \qquad \frac{+7.4}{21.4}$$

Completing the section,

$$\frac{0}{14} \qquad \frac{+6.4}{20.4} \qquad \frac{+7.0}{0} \qquad \frac{+7.4}{21.4} \qquad \frac{0}{14}$$

Computing,

$$\tfrac{1}{2}\,(6.4 \times 14 + 7 \times 41.8 + 7.4 \times 14) = 242.9 \text{ sq. ft.}$$

This readily reduces to $\dfrac{6.4 + 7.4}{2} \times 14 + \dfrac{7}{2} \times 41.8$, or the average of the end cuts, times one-half the roadbed, plus one-half the center cut, times the distance between slope stakes, which is the commonly used method of calculation for three-level sections.

The above method is just as easily used for side-hill sections and does not have the disadvantage of some similar methods where the zero measuring point is moved from the center stake to the grade point.

Given the section below, the width of roadbed being the same as the cut and fill sections above:

$$\overset{L}{\frac{-3.2}{14.8}} \qquad \frac{-2.6}{11} \qquad \frac{0}{6} \qquad \overset{C}{\frac{+1.0}{0}} \qquad \frac{+3.0}{12} \qquad \overset{R}{\frac{+3.4}{17.4}}$$

Completing,

$$\frac{0}{10} \qquad \frac{-3.2}{14.8} \qquad \frac{-2.6}{11} \qquad \frac{0}{6} \qquad \frac{+1.0}{0} \qquad \frac{+3.0}{12} \qquad \frac{+3.4}{17.4} \qquad \frac{0}{14}$$

$$\tfrac{1}{2}\,(3.2 \times (-1) + 2.6 \times 8.8) = 9.84 \text{ sq. ft. fill}$$

$$\tfrac{1}{2}\,(1.0 \times 18 + 3 \times 17.4 + 3.4 \times 2) = 38.5 \text{ sq. ft. cut}$$

It is not necessary actually to write in the values of zero over one-half the roadbed in completing the section, as the computer can readily carry them in his mind, but if he desires to write them in he can do so in the note book where the cross-sections are recorded. It is expected that the levels and cross-sections will be recorded on the left hand page, so that there is sufficient room on the right hand page for separate columns for cut and fill areas and volumes, and also a column for mass volumes.

The sections above were completed by adding zero over one-half the width of cut or fill roadbed since the sections represent single track roadbeds and the base line is the center line of the track. On multiple track construction or where the base line is not the center line of the roadbed, the sections are completed by adding zero over the distance from the base line to the edge of the roadbed on either side.

IRREGULAR SECTIONS

The term "irregular section" is assumed to apply to any borrow pit, gravel pit, or any incomplete or other cut or fill that does not have a constant width roadbed with uniform slopes on the two sides.

This type of section in general involves more work in computations than the regular sections, but there is no reason for this being true. The normal method of taking notes is to take cross levels across the section at intervals, recording the elevations of all criticial points on each section.

Sometimes these cross-sections are plotted on cross-section paper and the areas computed by calculating the area of each separate geometric figure involved. This involves a great deal of work and expense.

Sometimes, for partial estimates, the areas are obtained from the plotted cross-sections by means of a planimeter. This is more rapid than computing, but unless the plotted cross-sections are desired for other purposes, the areas can be computed directly from the notes.

In Fig. 2 an irregular section is shown for a cut. The values shown on the figure represent the elevations above the datum plane, which in this case is the bottom of the cut, and therefore represent the normal method of recording cross-section notes. They are shown over the corresponding distance out from the base line.

This area can be computed by averaging two adjoining elevations and multiplying by the distance between them, this method being similar to the first one under Regular Sections as the areas of trapezoids are being computed. One set of calculations is made for the ground line and another for the cut, and the difference between the two areas gives the correct area.

To illustrate:

$$\frac{30+32}{2}\times 30+\frac{32+30}{2}\times 10+\frac{30+27}{2}\times 10+\frac{27+28}{2}\times 10+$$
$$\frac{28+25}{2}\times 11=2091.5$$

$$\frac{30+20}{2}\times 10+\frac{20+13}{2}\times 4+\frac{13+10}{2}\times 6+\frac{10+2}{2}\times 7+$$
$$\frac{2+0}{2}\times 3+\frac{3+0}{2}\times 3+\frac{3+8}{2}\times 4+\frac{8+11}{2}\times 6+$$
$$\frac{11+17}{2}\times 4+\frac{17+25}{2}\times 4=653.5$$

Area $= 2091.5 - 653.5 = 1438$ sq. ft.

It is not necessary that the bottom of the cut be horizontal nor that the datum plane be at the bottom. Zero datum can be assumed anywhere. The base line can be on one side of the cut instead of in the center. Dividing by two can be done once after all additions and subtractions.

The measurements for original ground line and final estimates are made by one railroad with a bar and rod, using the bar with a spirit level to measure horizontal distances and an ordinary level rod to measure vertical distances. The same care is not necessary for monthly estimates, nor need the sections be taken at as frequent intervals. In steep rock cuts they often take final cross-section with a transit, measuring the vertical angles and using a tape, the distance being measured along the line of sight.

A method of computation similar to the second method used above for regular sections is also often used. In using this method it is not necessary to determine the elevations of the various points, but merely to record the rod readings. The section is completed in this case by adding the amount of the opposite end-reading over zero to each end.

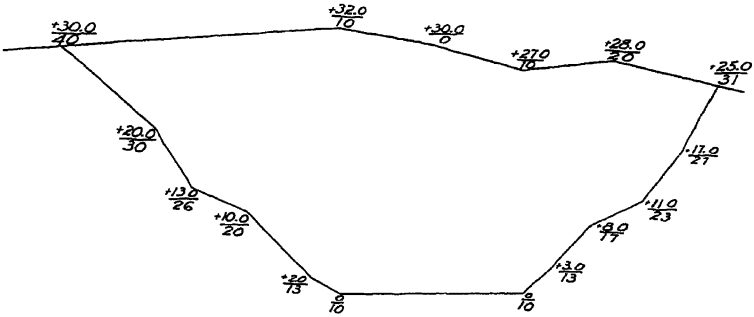


FIG. 2

In Fig. 3 is shown the same section as in Fig. 2. The figures above represent the rod readings on the original ground surface and those below, the rod readings in the completed cut, the level being at a different elevation in each case.

The first set is completed as below:

9	4.0	2.0	4.0	7.0	6.0	9.0	4
0	40	10	0	10	20	31	0

Computing as before,

$\frac{1}{2}(9\times(-40)+4\times(-10)+2\times 40+4\times 20+7\times 20+6\times 21+9\times(-20)+4\times(-31)) = -139$ sq. ft., which is the area above the straight dotted line joining the two end readings. The negative sign indicates that a cut is necessary to bring the original surface to a straight line.

For the completed ditch,

7	2	12	19	22	30	32	32	32	29	24	21	15	7	2
0	40	30	26	20	13	10	0	10	13	17	23	27	31	0

Computing,

$\frac{1}{2}(7 \times (-40) + 2 \times (-30) + 12 \times 14 + 19 \times 10 + 22 \times 13 + 30 \times 10 + 32 \times 13 + 32 \times 20 + 32 \times 13 + 29 \times 7 + 24 \times 10 + 21 \times 10 + 15 \times 8 + 7 \times (-27) + 2 \times (-31)) = 1299$ sq. ft., which is the area below the dotted line.

The total area then is $1299 + 139 = 1438$ sq. ft.

It will be noted that the number of computations involved in this method is more than in the one just preceding. This method has one advantage, however, in that it is only necessary to record rod readings and ignore true elevations. It is not even necessary that the line of sight be level, but only that it be straight. For monthly estimates it would be sufficiently accurate to stretch a string across at each section.

In either method a permanent base line should be laid out at the time the cross-sections are made of the original ground surface. If the location of the edge of the ditch is known in advance, readings should be taken at those points. If not, the preliminary cross-sections should be tied to some permanent bench mark, so that the edge of the ditch may be co-ordinated with the original sections later. Otherwise it will be necessary to prorate to obtain this value.

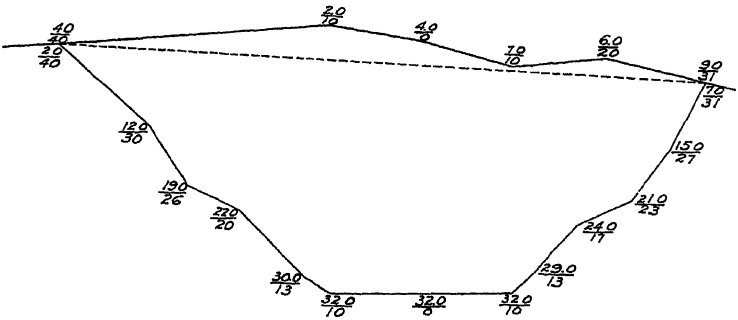


FIG. 3

All of the above methods of calculating are equally applicable to cuts or fills, or a combination of the two.

VOLUMES

In grading, volumes are ordinarily computed by the average end area method, in which the average of the two end cross-sections multiplied by the distance between them gives the volume in cubic feet. This divided by 27 gives the volume in cubic yards.

On roadbeds the cross-sections are normally taken 100 ft. apart, with intermediate sections at breaks in the ground or at grade points. On irregular sections it may be necessary to take the cross-sections at more frequent intervals. For monthly estimates the distance between sections may be increased.

Appendix H

(10) HEAVING TRACK

C. S Robinson, Chairman, Sub-Committee; A. L. Bartlett, J. D. Elder, R. L. Kittredge, E. R. Lewis, R. T. Middleton, W. A. Murray.

Cause and prevention of heaving track due to frost action and maintenance methods while the effects of heaving are present.

Cause

When water collects unevenly under the track and expands, due to freezing, the track is lifted higher above the wet spots than the dry spots and produces what is known as "heaved track." The extent of heaving depends upon the character and condition of material in the ballast and subgrade, amount of moisture retained and the extent and duration of low temperature.

Prevention

The cost of maintaining shimmed track is a very considerable factor and the application of shims and braces in territories where relatively high-speed trains are run requires the attention of a maintenance force experienced in this work.

The loss of service life in cross-ties due to spiking of shims and braces is readily appreciated by a glance at the picture below.

ILLUSTRATING THE DAMAGE TO CROSS-TIES FROM SPIKING OF SHIMS AND BRACES

With the tendency towards increased axle loads and higher speeds the difficulty of maintaining good riding track where shimming is required is more important, and, therefore, careful study and considerable expenditure are warranted to eliminate heaving track where possible.

In new construction too much emphasis cannot be placed on the care that should be exercised to obtain good surface and sub-surface drainage,

and depressions that will hold water or prevent proper drainage must not be allowed. A proper depth of suitable ballast is a primary requisite.

On existing tracks drainage and clean ballast are the greatest factors in eliminating heaving of track.

Where heaving occurs in isolated places on fills much may be accomplished by digging out these places; the subgrade being removed two feet or more to provide proper drainage and prevent formation of water pockets; the excavation backfilled with locomotive ashes or clean coarse gravel; or other porous material and then applying an adequate depth of good ballast.

In wet cuts the installation of perforated underdrains backfilled with porous material gives excellent results.

Also, much may be accomplished by plowing off the subgrade shoulder with spreader to insure that there is no material that prevents the drainage of the ballast section or that would form water pockets.

Where heaving extends over a considerable territory a thoroughly ditching and ballast program is the only satisfactory method of prevention.

Maintenance Methods

Where the action of the frost requires that the track be shimmed, track must be brought properly to surface by shimming on each side of the high spots.

Shimming must be done in such a manner as to give the track the proper surface, gage, line and strength, and a runoff of sufficient length provided to give a good riding condition.

Sawed and bored shims of approved hard woods and shim spikes of proper length should be used.

The track to be shimmed should first have the ties thoroughly cleared free from snow and ice. Shims should be placed squarely in relation with the tie and spiked through holes provided. Shims should not be driven in at an angle between the spikes.

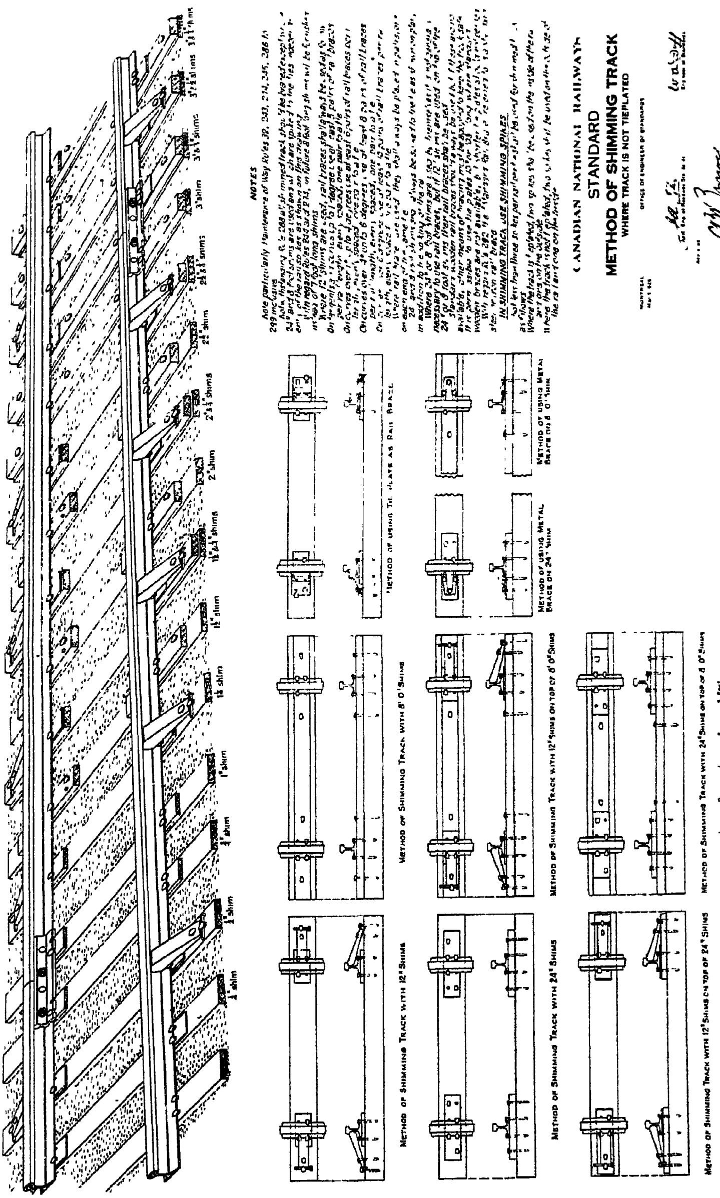
Shim spikes, as a rule, should be of sufficient length to give a penetration in the tie equal to the penetration on unshimmed track.

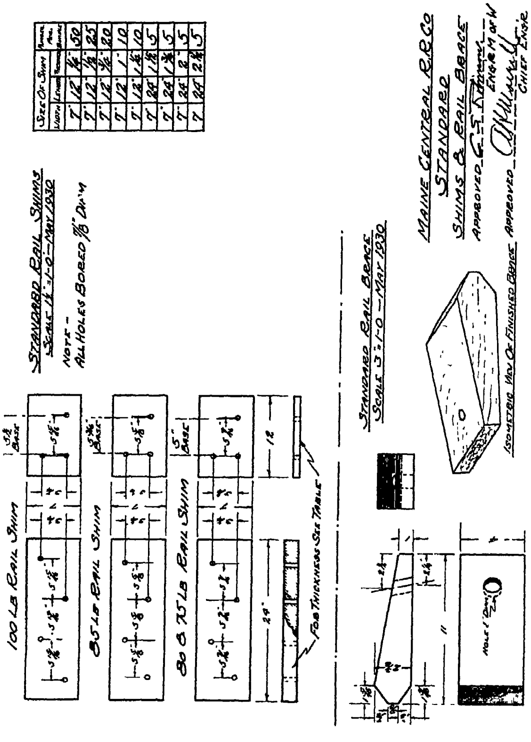
The track gages and levels should also be used to insure that the track is brought to good surface, and proper elevation maintained on curves and their approaches.

Rail braces and gage rods should be used to maintain proper gage and to prevent the rails from canting or spreading.

Shimmed track must be given daily inspection to insure that the bracing is in proper shape and that the shims are being changed as required, both while the frost is going in and coming out.

Shims, as a rule, vary in thickness from ¼ in. to 3 in. The following statement and plans show standard shims and braces in use on several roads subject to heaving track, and instructions as to their application:


CANADIAN NATIONAL RAILWAYS
STANDARD
METHOD OF SHIMMING TRACK
WHERE TRACK IS NOT TIEPLATED
NOTES
Method of Shimming Track with 12" Shims
Method of Shimming Track with 24" Shims
Method of Shimming Track with 12" Shims on top of 24" Shims
Method of Shimming Track with 8' 0" Shims
Method of Shimming Track with 12" Shims on top of 8' 0" Shims
Method of Shimming Track with 24" Shims on top of 8' 0" Shims
Method of using Tie Plate as Rail Brace
Method of using Metal Brace on 24" Shim
Method of using Metal Brace on 8' 0" Shim
IN SHIMMING TRACK USE SHIMMING SPIKES
Scale


100 LB RAIL SHIM
85 LB RAIL SHIM
80 & 75 LB RAIL SHIM
FOR THICKNESS SEE TABLE
STANDARD RAIL SHIMS
SCALE 1½"=1'-0 — MAY 1930
NOTE - ALL HOLES BORED 7/8" DIAM
SIZE OF SHIM
WIDTH LENGTH THICKNESS NUMBER REQ.
7" 12" ¼" 50
7" 12" ½" 25
7" 12" ¾" 20
7" 12" 1" 10
7" 12" 1¼" 10
7" 24" 1½" 5
7" 24" 1¾" 5
7" 24" 2" 5
7" 24" 2¼" 5
STANDARD RAIL BRACE
SCALE 3"=1'-0 — MAY 1930
ISOMETRIC VIEW OF FINISHED BRACE
MAINE CENTRAL R.R.CO
STANDARD
SHIMS & RAIL BRACE
APPROVED
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CHIEF ENGR

REPORT OF COMMITTEE XXII—ECONOMICS OF RAILWAY LABOR

F. M. THOMSON, *Chairman;*
LEM ADAMS, *Vice-Chairman;*
J. J. BAXTER,
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H. M. STOUT,
G. M. STRACHAN,
W. H. VANCE,
CALE WAMSLEY,

Committee.

To the American Railway Engineering Association:

Your Committee respectfully presents herewith report covering the following subjects:

(1) Revision of Manual.

(2) Analysis of operation of railways that have made marked progress in the reduction of labor required in maintenance-of-way work.

(3) Effects of recent developments in maintenance-of-way practices on gang organization (such as use of heavier rail, treated ties, and labor-saving devices, which make practicable small section forces, and conducting the major part of maintenance work with extra gangs), collaborating with Committees I—Roadway, II—Ballast, III—Ties, IV—Rail, V—Track, and XVII—Wood Preservation (Appendix A).

(4) Economies resulting in the diversion of traffic on multiple track lines for maintenance purposes (Appendix B).

(5) Practical methods of hand and spray painting (Appendix C).

(6) Practical methods of stabilizing maintenance-of-way forces.

(7) Methods of weed killing, collaborating with Committee XVII—Wood Preservation and Special Committee on Maintenance-of-Way Work Equipment.

Action Recommended

(1) No revision of Manual recommended.

(2) That the subject be continued for further study.

(3) That the report be accepted as information and the subject be continued for further study (Appendix A).

(4) That the report be received as information, the conclusions be approved for publication in the Manual, and the subject be discontinued (Appendix B).

(5) That the subject be continued for further study (Appendix C).

(6) That the report be received as information, the conclusions be approved for publication in the Manual and the subject be discontinued.

(7) That the subject be continued for further study.

Respectfully submitted,

THE COMMITTEE ON ECONOMICS OF RAILWAY LABOR,

F. M. THOMSON, *Chairman.*

Appendix A

(3) EFFECTS OF RECENT DEVELOPMENTS IN MAINTENANCE-OF-WAY PRACTICES ON GANG ORGANIZATION (SUCH AS USE OF HEAVIER RAIL, TREATED TIES, AND LABOR-SAVING DEVICES, WHICH MAKE PRACTICABLE SMALL SECTION FORCES, AND CONDUCTING THE MAJOR PART OF MAINTENANCE WORK WITH EXTRA GANGS)

F. S. Schwinn, Chairman, Sub-Committee; A. E. Botts, H. F. Fifield, F. J. Meyer, A. N. Reece, G. B. Farlow, Wm. Carpenter, H. M. Stout, J. J. Baxter, John Evans, C. H. R. Howe, C. H. Paris, E. E. Oviatt, H. A. Cassil, J. A. Parant, T. S. Bond.

The subject was taken up by personal correspondence with the chief maintenance officers of twenty representative railways in all parts of the country, eighteen replies being received. These indicated, almost without exception, that the railways had adopted heavier rails, improved ballast sections and treated ties as standards, and that the use of labor-saving devices, particularly tie tampers, ballast cleaners and discers, track mowers and burners, rail laying machines, ditchers, spreaders and hoists, had become very nearly universal.

The general trend of the replies, however, was to the effect that the resulting economies had not made much change in gang organization beyond a reduction in the unit labor requirements for performing certain operations. While the labor needed for relaying a ton of rail, placing a cubic yard of ballast or similar operation had been reduced, with corresponding reduction in the size of extra gangs required for certain jobs, there had been but little effect on the size of section gangs. This was explained generally by the statement that economies which were made in the unit cost were offset to a large measure by the requirements of higher standards of maintenance, greater train speeds and heavier traffic.

In an effort to more fully develop the subject the correspondence was followed up with a selected number of railways which might be in the best position to furnish detailed information. The results of this correspondence are briefed as follows:

(I) RAILWAYS WHICH HAVE INCREASED LENGTH AND DECREASED NUMBER OF SECTIONS

The Atchison, Topeka and Santa Fe Railway reports no changes in maintenance-of-way practices as affecting gang organization. Rail renewals and ballasting are handled by extra gangs supplied with necessary modern labor-saving equipment. Some reduction in section forces has been made through the use of motor cars and consequent lengthening of sections.

The Delaware, Lackawanna & Western Railroad has not endeavored to transfer ordinary section work to extra gangs, but, on the contrary, leans toward the tendency of giving more work to section forces, this including some rail renewals and tie and ballast renewals when labor is plentiful. A

material reduction has been made in the number of sections by consolidation of adjoining sections, but this has been done primarily with the view of economizing in supervision, cost of flagging and similar items, and has been found very successful where coupled with up-to-date motor cars, trailers, tie tampers and similar equipment

(II) RAILWAYS WHICH HAVE REDUCED TRACK FORCES

The Baltimore & Ohio Railroad has not undertaken to transfer normal section maintenance to large extra gangs. Results obtained through the use of improved materials and labor-saving machines have been very noticeable, records indicating a reduction of 25 per cent in track labor during the past ten years, and, in the case of rail laying, it now requires that 6.5 man hours per ton as compared with 9.6 man hours ten years ago.

The Chicago & Illinois Midland Railway has in recent years made large reductions in section forces as a result of economies obtained by the use of improved materials and labor-saving equipment, but it has not transferred ordinary section work to extra gangs or changed its standard maintenance practices.

The Delaware and Hudson Company has not transferred any work commonly performed by section gangs to extra gangs, but, on the contrary, lays much of its rail during winter months by consolidating the section forces in large gangs. Track labor expense has been consistently reduced by means of improved supervision, organization, stabilization of forces and the use of labor-saving equipment.

The Missouri Pacific Lines in Texas have made no changes in standard maintenance practices affecting gang organization; all ordinary maintenance being assigned to section gangs, ballasting and rail renewals being handled by extra gangs. Results of the use of improved track materials and modern labor-saving equipment have been noticeable in average amount of track labor required, this having been reduced approximately 30 per cent during the past five years in the face of a large increase in traffic.

The New York Central Railroad has made no change in its practices with regard to track maintenance, extra gangs being used in ballasting and new rail laying. Section forces continue to handle all ordinary maintenance and are held responsible for such maintenance. Economies have been obtained through the use of modern labor-saving equipment but the number of men employed on track maintenance has not been reduced.

The Northern Pacific Railway has not transferred to extra gangs any work commonly included as section work. Extra gangs are utilized only for ballasting and rail renewals. Track maintenance expenses have been reduced in recent years as the result of introduction of creosoted ties, heavier rail and improved ballast. The only change in extra gang practice has been in the adoption of the plan for carrying out all main track relays with a system of relay gangs.

The Southern Pacific Company continues to handle the major part of ordinary maintenance with section forces. Rail renewals and ballasting are handled by extra gangs especially organized for such work. In addition, large maintenance gangs are used for resurfacing track out of face, this

being done in connection with pneumatic tampers and ballast cleaning. An appreciable reduction in total track labor has been shown as the result of the use of heavier rail, creosoted ties and labor-saving equipment of all types. Some reductions in cost have been made through increasing the length of sections.

(III) RAILWAYS WHICH HAVE TRANSFERRED SECTION WORK TO EXTRA GANGS

The Chicago, Milwaukee, St. Paul and Pacific Railroad has made large reductions in its section forces and has transferred resurfacing and heavy tie renewals to extra gangs fully equipped with labor-saving machines. This has permitted taking full advantage of every possibility in securing economies from these machines. These large maintenance gangs are able to resurface an average of 2.8 feet per man hour, including tie renewals averaging approximately 700 per mile. Improvements in supervision and organization and the use of labor-saving machines have reduced labor and work train costs in ballasting about 20 per cent in the past three years, and in rail renewals about 40 per cent in the past six years.

The Great Northern Railway has transferred certain maintenance work to a floating gang on each supervisor's district, this gang being made up through a corresponding reduction in section forces partially obtained by increasing the length of sections. It is fully equipped with labor-saving machines required for the work assigned to it in connection with resurfacing and the attending tie renewals and application of additional ballast. This has eliminated the need of supplying each section with such equipment. This change in practice has resulted in the performance of more and better work of this nature with economies estimated at over $2,000 per year per section. No changes have been made in ballasting and rail renewal practices, this class of work being handled as before by specially organized and equipped extra gangs. The composite result of changes in organization, improved equipment and heavier track materials is a reduction of about 40 per cent in track labor as compared with pre-war requirements, this reduction being obtained in the face of heavier traffic demands.

The Pennsylvania Railroad has assigned all heavy repair work, including rail renewals, track raising, tie spacing and renewals, and heavy work of all kinds to large extra gangs, with a resulting reduction in the size of section gangs, this last being obtained in a few instances by the lengthening of sections. The purpose of these changes was to stabilize the ordinary maintenance forces, permit section forces to devote a greater portion of their time to maintaining the riding conditions of the track under heavier traffic requirements and to permit concentration of heavy repairs in a smaller number of larger gangs fully equipped with modern labor-saving machinery which could be kept working continuously instead of intermittently. Results of labor-saving machinery are indicated by the fact that it required one man-hour to install 15 feet of 130-lb. rail using hand labor throughout, while with the present modern equipment one man-hour is needed in placing 34 feet of 130-lb. rail.

(IV) RAILWAYS WHICH REPORT NO EFFECTS ON GANG ORGANIZATION

The Chesapeake and Ohio Railway reports no reduction in size of section gangs or change in gang organization as a result of economies obtained from modern labor-saving equipment or improved track materials. No section maintenance work has been transferred to extra gangs.

The Chicago, Rock Island & Pacific Railway reports securing very favorable economies from the use of labor-saving equipment, but such savings have been offset by increased demands resulting from heavier traffic, and no changes in gang organization have been undertaken.

The Erie Railroad reports that no changes have been made in its maintenance practices which would transfer to extra gangs any work commonly included as section work.

The Michigan Central Railroad reports that section gangs have not been reduced as the result of improved track materials and ordinary maintenance work has not been transferred to extra gangs.

The Pere Marquette Railway has continued its past practice of handling all regular maintenance through section gangs and performing ballasting and rail renewal work with extra gangs No reductions have been made in track forces.

The Western Pacific Railroad has made no changes in its standard practices. All ordinary maintenance is handled by section gangs and small extra gangs, one of which is assigned to each roadmaster's district. Rail renewals and ballasting are handled by large extra gangs equipped with labor-saving machines designed for such work.

An analysis of the replies briefed above leads to the following observations:

(a) Nine of the reporting railways, or 50 per cent, advise they have made reductions in track forces. In a number of instances such reductions have been made by increasing the length and decreasing the number of sections, while in other cases forces have been reduced without changing the number of sections.

(b) Three of the reporting railways, or 17 per cent, advise they have transferred work generally considered as ordinary track maintenance from section gangs to extra gangs.

(c) Six of the reporting railways, or 33 per cent, advise they have made no changes in their gang organization.

Conclusions

(1) Recent developments in maintenance-of-way practices such as the use of improved materials and labor-saving devices have reduced the amount of track labor required for adequate maintenance.

(2) It is apparent that these developments in maintenance-of-way practices should permit the transferring of the heavier routine maintenance work from section gangs to specialized gangs equipped with modern labor-saving machinery with large resulting economy.

Recommendation

The Committee recommends that this report be received as information and the subject be continued.

Appendix B

(4) ECONOMIES RESULTING IN THE DIVERSION OF TRAFFIC ON MULTIPLE TRACK LINES FOR MAINTENANCE PURPOSES

E. T. Howson, Chairman, Sub-Committee; Lem Adams, Wm. Carpenter, G. B. Farlow, H. F. Fifield, H. H. Harsh, E. E. Oviatt, J. C. Patterson, G. A. Phillips, D. M Rankin, A. N. Reece, H. M. Stout, G. M Strachan, W. H. Vance

The exacting demands for greater production and lower costs in railway maintenance, together with the wider use of power machines and tools by maintenance of way forces, are necessitating drastic changes in many of the former methods of doing work. Some of these newer practices, which have resulted from the changing conditions which the maintenance-of-way department must meet have become well established, while others are still in the transitional stage. The subject which was assigned to this Sub-Committee falls into the latter class.

To determine the extent to which the practice is followed of diverting traffic on multiple track lines to facilitate maintenance operations by giving uninterrupted use of the tracks during the progress of the work, a questionnaire was sent to 32 Chief Engineers and Engineers Maintenance of Way of large roads to develop information concerning their practices. They were asked to describe the provisions that are made for handling traffic during the periods of diversion; to give data as to the benefits accruing from the unrestricted use of the track and the savings that have been effected by this practice; and to state what effect this practice has had on the transportation department and the attitude of the operating officers.

Replies were received from 31 of these roads having a mileage in excess of 197,000. Only two of these roads do not under any circumstances divert traffic to facilitate the work of the maintenance forces. Eight other roads gave conditional answers, saying that traffic has been diverted in some instances, but that it is not the general practice to do so. The replies from this group of roads indicate that the maintenance officers are favorably disposed towards the practice of diverting traffic but do not do so either because of opposition on the part of operating officers or because the density of traffic makes it impracticable. The maintenance officers on these roads are convinced that they would be able to effect economies by diverting traffic to secure the uninterrupted use of the track, but have no data as to the amount of saving that could be effected. The remaining 21 roads report that they make a general practice—a few limit it to laying rail—of diverting traffic for this purpose and find definite economy in doing so.

PROVISIONS FOR HANDLING TRAFFIC

The provisions for handling the traffic during the diversion period, as outlined in the replies, vary between rather wide limits, even on individual roads; depending primarily on the density of traffic, the method of opera-

tion involved, to some extent on the grades and alinement over the sections in question, and the character of the work being performed.

In case the work requires the use of one track of a double track line during bridge repair or renewal, so that only a few hundred feet of single track is necessary, some roads install temporary hand-thrown switches at each end, or construct a gauntlet, and handle train movements with a flagman who has instructions to give preference to passenger trains and certain important freight trains. One road, however, installs spring switches at such locations set for the normal direction of train movement.

Where the track that is to be killed is longer, requiring artificial means of communication, temporary crossovers are installed and the provisions for handling trains range from a special form of manual block operation independent of the dispatcher and handled by flagmen at each end, who communicate with each other by telephone, to single track operation by train order only. In the latter case, temporary telegraph offices are installed and a qualified operator is placed at each end of the single track. In some instances a trainmaster is placed in charge of the train movement and the flagmen or operators report to him. Two roads require that a pilot engine precede every train.

On a number of roads, the single track extends from station to station and the movement of trains is under the direction of the dispatcher and the regular station operators. Where permanent facing crossovers are available, they are used in making the diversion; otherwise, temporary facing crossovers are installed to avoid back-up movements.

Four roads reported that on some sections of their lines interlockings are in service at practically every station, in which case the diversion is handled through the interlocking. Two of these roads which commonly use the tracks without reference to normal direction, report that traffic diversion is so nearly a routine matter that no special provisions are necessary, except that they get permission to occupy the tracks during a certain period of the day and notify the dispatcher of the arrangement. Still another road handles the diverted traffic by signal indication only, on those sections that are signaled for both directions. One road reports that where there are three or more tracks in service, the traffic is routed in the normal direction over the remaining tracks.

Some roads divert freight trains only and require that the track under repair be restored for all regularly scheduled passenger trains. Others shift the hours of work to avoid passenger trains, while still others divert passenger trains but shift the tour of duty to take advantage of the light traffic period of the day.

BENEFITS FROM DIVERTING TRAFFIC

The benefits which accrue to the maintenance-of-way department through the unrestricted use of the track include increased output, thus shortening the time necessary to complete the work; full use of power equipment, which adds materially to the economy of its use; the elimination of the necessity for the removal of heavy machines such as rail cranes, compressor or generator-power plants, power jacks, adzing machines, etc., from the track to clear trains; the ability to use larger gangs and organize them on a production basis, thus securing better supervision and a higher

quality of work, as well as greater output per man; a marked decrease in the time lost in waiting for trains which fail to arrive at the point of the work according to schedule; the elimination of the time lost in restoring the track for the passage of trains; the ability to maintain correct expansion when laying rail because trains are kept off of the track until rail anchors can be applied; the possibility of work trains being able to work continuously, as they also have the benefit of the dead track; and an increase in safety since fewer personal injuries occur.

EFFECT ON THE TRANSPORTATION DEPARTMENT

On lines of or during periods of extremely dense traffic, particularly where there are numerous high-speed passenger trains, the diversion of the traffic may be difficult but seldom impracticable. In some instances objection has been raised to the practice in automatic train control territory on the ground that the train-control apparatus must be cut out while passing over the single track, and some difficulty is encountered in doing this.

In general, the transportation department is benefited by the shorter time required to do the work as compared with methods that entail constant interruption. Consolidation of several gangs, or the use of a larger gang, reduces the number of points where speed restrictions are necessary, so that over a given district traffic may be considerably expedited It is the general opinion of those officers who are most experienced in this practice that, except in special cases, operating conditions are materially improved.

Of necessity, some delay will be met by certain trains but these are usually inferior trains. If the two departments work in close harmony, the total amount of this delay can be reduced to a surprisingly small total. On some roads inferior trains are scheduled out of terminals at such hours as to make their influence practically negligible Where this is not done, however, the total delay is almost invariably less than that suffered as a result of slow orders, waiting for the track to be restored and the longer time required to complete the work.

ATTITUDE OF OPERATING OFFICERS

It has been the almost invariable experience that, when the proposal to adopt this practice has first been presented to operating officers, they have opposed it. It is of interest, therefore, that the 21 roads reporting that the practice is general on their lines, say, without exception, that the maintenance forces are accorded full co-operation and that the operating officers are heartily in favor of this method of doing the work.

ECONOMIES THAT ARE EFFECTED

It is obvious that the actual saving which can be effected by giving the maintenance forces the unrestricted use of any track will depend on several factors, the most important of which are the number of train movement over the track and the size of the gang. Observations on the Chicago & Eastern Illinois indicated that a period of 20 minutes is required to close the track for each train movement when laying rail. If the gang contains 60 men, this delay is equivalent to 20 man hours. Moreover, if the train does not arrive exactly on schedule, the work suffers further delay. Again, two flagmen are required, which increases the expense of this method.

Other roads estimate the saving when laying rails as follows: The New York, New Haven & Hartford, $1 a ton; Norfolk & Western, $1 to $2; Boston & Maine, $2 to $3, installing tie plates 1½ cents each; Lehigh Valley, $10 per ton maximum; Illinois Central, 15 per cent; Canadian National, 25 per cent; Chicago & Alton, 30 to 40 per cent, equivalent to $300 per mile; Baltimore & Ohio, 35 to 40 per cent; Cleveland, Cincinnati, Chicago & St Louis, a maximum of 50 per cent; Chicago, Burlington & Quincy, $50 to $100 a mile and $15 to $30 a day for work-train service; Northern Pacific, $100 a mile; Atchison, Topeka & Santa Fe, $120 a mile; and Wabash, $250 a mile.

A few roads have kept records which show definitely the savings they have been able to effect by diverting the traffic and giving rail gangs the unrestricted use of the tracks. The Chesapeake & Ohio, which follows the practice of cost accounting for all classes of maintenance work, reports saving as high as $190 a mile. The Erie reports that under varying conditions of traffic the saving on one division amounted to three cents to four cents a linear foot of rail laid, equivalent to $320 to $420 per miles of track. Another division on this road reported savings as high as 60 per cent, while two other divisions made savings of $165 and $125 a day, respectively, equivalent to four hours and three hours for the respective gangs.

The Union Pacific adopted the practice, in 1930, of diverting traffic to facilitate maintenance-of-way work. Early in the year this plan was given a trial in renewing the ties on a double-track bridge near Fort Steele, Wyo. It was estimated that $2,000, or $2 per linear foot of bridge, was saved in the cost of the work and that further economy resulted from not having a slow order in effect for an extended period.

During June and July, 1930, this road laid 38 miles of rail on an important double-track line diverting traffic for the benefit of the rail gang. The gang laid an average of 2298 ft. more rail per day than when working under traffic, and that the cost per mile for labor was reduced from $480 to $272, a saving of $208. Of this amount, $162 was allocated to the elimination of interruptions by reason of diverting the traffic. In addition, $38 a mile was saved in the cost of distributing the new rail, while there was a further saving of $20 a mile in material costs by reason of not cutting rail for closure to permit the passage of trains. The total direct expense to the transportation department was $577.33 for switch tenders during the progress of the work. The saving was, therefore, $200 a mile for labor and $20 for material, or $220, which amounted to $8,360 for the 38 miles involved. Deducting the cost of the switch tenders, the net saving was $7,782.67.

The total number of train movements between the hours of 8 a.m. and 5 p.m. during the progress of the work was 642. The aggregate delay to freight trains was 64 hr. 25 min., and to passenger trains 17 hr. 40 min., an average for all trains of approximately 8 min. each. This compares with an estimated total delay of 35 hr. for freight trains and none for passenger trains if the traffic had not been diverted.

Commensurate savings are estimated or reported in ballasting and track surfacing. As in rail laying, the amount will vary according to the density of the traffic, the size of the gangs and the character of the tool equipment which is furnished to them. Accordingly, the estimates of the savings that can be made range from 15 per cent on light traffic lines to 60 per cent

where the traffic is heavy; and from $50 to $1500 a mile. The Erie reports savings on different divisions ranging from $105 to $160 a mile.

The Chicago, Milwaukee, St. Paul & Pacific was able to compare the cost of ballasting on a single-track line having an average of 15 to 17 trains, with a maximum of 25 a day, during the working hours, with the same work where the traffic was diverted on a double-track line. In both cases, the work was done by the same gang; the same foreman and supervisory officers were in charge; and the tool equipment was the same. In the latter case, however, about 100 more ties were renewed per mile than in the single track. Under these conditions a saving of $576 a mile resulted where the gangs were given the unrestricted use of the track.

Summary

The investigation made by the Sub-Committee and the reports of maintenance officers from widely separated sections of the country indicate that marked savings can be effected by diverting traffic on multiple track lines to give the maintenance forces unrestricted use of the track. The provisions necessary for this diversion are simple and so flexible that they can be adapted for practically every condition of grade, alinement, character of traffic and method of operation. Experience has shown that the interference with train movement, except in special cases, is little, if any, greater than when the work is carried out under traffic.

In general, operating officers are somewhat skeptical in their attitude until they have given the plan a trial, after which they are usually willing to co-operate with the maintenance department to the fullest extent. The time required to complete a given project is shorter, thus reducing the period of interference with train movements, while larger or consolidated gangs can be employed, with the result that slow orders are eliminated or decreased and the obstructions to traffic are concentrated at a single point.

Conclusions

As a result of its study, the Committee offers the following conclusions:

1. Under all but the most intensive traffic the practice of diverting traffic on multiple track lines to facilitate the work of the maintenance forces is feasible and when employed results in definite savings in the cost of doing the work, as well as in net savings to the railway.

2. In addition to the economies effected, there are added benefits in larger production, better work and greater safety to the workmen.

3. The provisions necessary for diverting the traffic are comparatively simple and can be varied to meet physical conditions or conform to operating methods.

4. There is little, if any, added interference with train movements while the work is actually under way and operating conditions as a whole are improved, as compared with doing the work under traffic by reason of the reduction in the time required for its completion.

Recommendations

The Committee recommends this report be received as information, the conclusions be adopted for printing in the Manual, and the subject closed.

Appendix C

(6) PRACTICAL METHODS OF STABILIZING MAINTENANCE-OF-WAY FORCES

Lem Adams, Chairman, Sub-Committee; H. A. Cassil, D. M. Rankin, W. G. Morgan, Cale Wamsley, E. E. Christoph, A. E. Botts, F. B. Doolittle, E. T. Howson, C. H. Paris, T. S. Bond, John Evans.

This subject, in some form, has been assigned to this Committee for many years.

The first report was completed in 1925, under the caption "Method of Programming Maintenance-of-Way Work, Looking to the Most Economical Application of Labor."

The study of this subject developed the following conclusions:

(1) The preparation of a budget of the work to be done during the year and the authorization of this budget for the year, if possible, or quarterly at least, sufficiently in advance of the inauguration of the work to enable materials and men to be collected in an orderly manner.

(2) The equalization of expenditures on roads where it is practical in accordance with the plan authorized by the Interstate Commerce Commission to eliminate the wide fluctuations in expenditures from month to month.

(3) The preparation of a detailed program in which the work authorized is scheduled so that it may be done at the most economical season consistent with the most efficient utilization of forces.

(4) The carrying of this program down to the local divisions and to the individual gangs on those divisions in order to enable the work of these men to be directed to the best advantage.

Again, in 1926, we had assigned "The Extent to Which It Is Practicable to Stabilize Employment in the Maintenance-of-Way Department, in the Interest of Efficiency, and the Necessary Measures."

The study of the Sub-Committee extended over two years, and the following conclusions evolved:

(1) The equalization of expenses permits work to be done at the most economical time, seasonal and traffic conditions considered. It also prevents the distortion of operating ratios, while by its application more uniform forces may be employed in maintenance-of-way work, thereby tending toward stabilization of forces.

(2) In consideration of the ultimate economy of building a strong personnel of labor forces and the immediate economy of holding experienced men in maintenance-of-way service, as much work as is economically possible should be done in the winter, thus stabilizing forces.

(3) Minimum cost is secured through uniform production; reductions in manufacturing costs are directly reflected in prices charged the railway; stabilization of forces with the resulting increase in the uniformity of use of materials will lead to savings in the cost of materials over and above the savings effected directly through the increased efficiency of the forces.

A resume of the Committee, in the 1928 Proceedings, summed up this subject as follows:

"Your Committee in its four-year study of this subject, feels that it has covered the ground very thoroughly, and the more we

have studied this matter of stabilizing employment, the more we are able to realize the economies, direct and indirect, that are to be obtained by having a trained force to perform our maintenance-of-way work, the same as we have for the maintenance of equipment.

We do not find that the average railway officer appreciates the fact that maintenance-of-way work requires trained men. Therefore, it should be to the interest of all concerned in maintenance-of-way work to sell this idea, with the end in view of ultimately obtaining a year-around experienced maintenance-of-way force."

We now have before us the matter of the practical application of stabilization. It is difficult to see how we are to retain a fairly stable force when we do not follow the "Equalization of Expenses" plan, and are faced with current reductions in our expenses to meet the fluctuations in earnings. The year we have just passed through has been a very trying one from this standpoint, so we readily appreciate the difficulty experienced in keeping a normal force.

Your Committee finds no justification for keeping the same number of men on a track section the entire year in territory where climatic conditions vary widely, but feels that a minimum number of men should be established for each section, based upon equated mile values, and this limit adhered to. This will provide continuous employment for a considerable proportion of the force, and train recruits for the permanent jobs.

As to bridge and building forces—the most practicable method seems to be that of a basic force assigned to a definite territory, this force to look after all general maintenance of bridges and buildings. Then when extraordinary work is needed or new buildings are to be constructed, a floating force will be added to take care of it, and the foremen recruited from the permanent organization. Plumbing and water service gangs should also be handled upon a similar basis.

The regular forces should work under a definite plan for making repairs; that is, certain items should be gone over at stipulated times. This will apply particularly to painting and cleaning of structures, where a definite time limit should exist between paintings. Differing conditions will require constant vigilance on the part of supervising officers to know that forces are properly apportioned, as such items as heavy rail, with new ballast, greatly reduce section work, tending to stabilize forces.

Conclusions

(1) The stabilization of forces is essential to maximum economies.

(2) The practical method of stabilizing maintenance-of-way forces is by the establishment of a basic force that can be economically employed during slack period, and by adding to this a *temporary* force as required, with provision for a definite date of termination for all such positions. This will provide a fairly uniform permanent force, and train recruits to fill jobs as vacated.

Recommendations

The Committee recommends that this report be accepted as information, the conclusions adopted for printing in the Manual, and the subject closed.

REPORT OF SPECIAL COMMITTEE ON STRESSES IN RAILROAD TRACK

A. N. TALBOT, *Chairman;*
C. B. BRONSON,
JOHN BRUNNER,
W. J. BURTON,
CHAS. S. CHURCHILL,
ROBERT FARIES,
C. W. GENNETT, JR.,
H. E. HALE,
J. B. JENKINS,
GEORGE W. KITTREDGE,
PAUL M. LABACH,
W. M. DAWLEY, *Vice-Chairman;*
C. G. E. LARSSON,
J. V. NEUBERT,
J. DE N. MACOMB,
G. J. RAY,
ALBERT REICHMANN,
H. R. SAFFORD,
EARL STIMSON,
F. E. TURNEAURE,
J. E. WILLOUGHBY,
Committee.

To the American Railway Engineering Association:

The Special Committee on Stresses in Track, co-operating with a similar committee of the American Society of Civil Engineers and with the American Railway Association, presents the following report of progress:

During 1930 the experimental work of the Committee has been given principally to the continuation of the investigation of the rail-joint. As preliminary to measurement of stresses in joint bars and joint bolts under train loads at various speeds, special extensometer bolts were designed and built and co-operation was given the Westinghouse Electric & Manufacturing Company in the development of a magnetic strain gage suited for use on joint bars and extensometer bolts and applicable in tests of rail-joint at all speeds—apparatus which has since proved satisfactory in the field tests. Magnetic strain gages for use in measuring stresses in rail have also been developed by the Westinghouse Company. In the use of these instruments, records are produced on photographic films through the agency of the oscillograph, which is placed in a shelter at some convenient point on the railroad right-of-way. In September and October, 1930, the staff of the Committee participated in tests of track made at Claymont, Delaware, on the Pennsylvania Railroad, co-operating with the Pennsylvania Railroad and the Westinghouse Electric & Manufacturing Company. In these tests, measurements of stresses in rail and rail-joints under the load of moving electric and steam locomotives and cars were made at speeds up to quite high rates. The data on rail-joints have been turned over to the Committee for reduction and analysis. Work has been started on studying the oscillograph record films obtained with the Westinghouse magnetic strain gage. The rail-joints tested included joint bars of different types. Stresses were measured along the tops and bottoms of both inner and outer bars and any changes in bolt tension as the load passed the joint were also measured. The records appear to be definite and satisfactory. As there are a large number of films, the time required for the work of reduction and analysis will be considerable. The Westinghouse engineers are engaged in studying similar records for rail stresses, both on the base of rail and on its web.

Plans had been made to conduct other tests on two or more railroads during the season of 1930, but it was not found practicable to do this. Tests on track are now planned for 1931.

Bulletin 330, October, 1930.

Considerable work has been carried out in laboratory tests on several types of rail-joint to determine several features in the action of the joints, including the influence of the position of the load as it moves along, the deflection and stiffness of joints, and the relative lateral and vertical movements between bar and rail. It is planned to go further in these laboratory tests.

The study of the experimental data has not progressed far enough to permit a detailed report to be made.

Respectfully submitted,

THE SPECIAL COMMITTEE ON
STRESSES IN RAILROAD TRACK,

A. N. TALBOT, *Chairman.*

REPORT OF COMMITTEE XIV—YARDS AND TERMINALS

H. L. Ripley, *Chairman*;
J. R. W. Ambrose,
Irving Anderson,
C. E. Armstrong,
J. E. Armstrong,
C. J. Astrue,
H. M. Bassett,
E. J. Beugler,
C. H. Blackman,
Alfred Bousfield,
N. C. L. Brown,
H. F. Burch,
W. A. Christian,
W. F. Cummings,
A. W. Epright,
E. H. Fritch,
O. H. Gersbach,
W. H. Giles,
E. D. Gordon,
F. W. Grace,
T. H. Greene,
R. J. Hammond,
G. F. Hand,
John V. Hanna,
E. M. Hastings,
H. O. Hem,

M. J. J. Harrison, *Vice-Chairman*,
W. H. Hobbs,
C. T. Jackson,
E. T. Johnston,
E. K. Lawrence,
Jos. L. Loida,
L. L. Lyford,
C. P. McCausland,
J. L. Miller,
A. Montzheimer,
C. H. Mottier,
A. E. Owen,
H. J. Pfeifer,
A. T. Powell,
T. R. Ratcliff,
H. M. Roeser,
W. B. Rudd,
W. C. Sadler,
C. U. Smith,
M. H. Starr,
E. E. R. Tratman,
H. L. Vandament,
A. P. Wenzell,
J. L. Wilkes,
W. M. Wilson,

Committee.

To the American Railway Engineering Association:

Your Committee respectfully presents herewith report covering the following subjects:

(1) Revision of Manual (Appendix A).

(2) Coach Yards (Appendix B).

(3) Effect of motor coach service on design and operation of way and terminal station facilities. The Committee has collected information and reports progress on this assignment.

(4) Provision for parking and garage facilities for private automobiles of railway passengers at passenger terminals and way stations (Appendix C).

(5) Effect of motor truck service on the design and operation of way and terminal freight station facilities. Your Committee reports progress.

(6) Hump yards (Appendix D).

(7) Co-ordination of facilities at rail and water terminals. Your Committee has collected information and reports progress.

(8) Design of airports in connection with railway yards. Owing to the enforced resignation of the Chairman, your Committee can only report progress.

(9) Scales used in railroad service (Appendix E).

(10) Bibliography on subjects pertaining to yards and terminals appearing in current periodicals (Appendix F).

(11) Furnish the Special Committee on Clearances the information required by it pertaining to yards and terminals. A designated member of your Committee has collaborated as requested.

Bulletin 331, November, 1930.

A

Action Recommended

(1) That the deletion recommended in Appendix A be approved.

(2) That the report on Coach Yards (Appendix B) be received as information and the subject discontinued for the time being.

(4) That the report on provision for parking and garage facilities for private automobiles, etc., be received as information.

(6) That the report on Hump Yards (Appendix D) be received as information.

(9) That the report on Scales used in railroad service (Appendix E) be received as information.

(10) That the Bibliography (Appendix F) be received as information.

Respectfully submitted,

COMMITTEE ON YARDS AND TERMINALS,

H. L. RIPLEY, *Chairman.*

Appendix A

(1) REVISION OF MANUAL

H. L. Ripley, Chairman, Sub-Committee; J. E. Armstrong, H. M. Bassett, E. J. Beugler, H. E. Burch, E. H. Fritch, R. J. Hammond, M. J. J. Harrison, L. L. Lyford, A. Montzheimer, H. J. Pfeifer, C. U. Smith, E. E. R. Tratman, J. L. Wilkes.

Delete from the Manual the section under the heading "V"—General Specifications for Master Scales, pages 1031-2, for reasons explained in the report of Sub-Committee 9.

The Committee proposes to clarify and rewrite these specifications during the coming year as they are now unsatisfactory and may be misleading.

Appendix B

(2) COACH YARDS

H. J. Pfeifer, Chairman, Sub-Committee; J. E. Armstrong, J. R. W. Ambrose, Irving Anderson, H. M. Bassett, E. J. Beugler, C. F. Blackman, H. F. Burch, W. F. Cummings, E. H. Fritch, W. H. Giles, F. W. Grace, R. J. Hammond, G. F. Hand, J. V. Hanna, E. M. Hastings, C. H. Mottier, T. R. Ratcliff, H. L. Ripley, W. B. Rudd, C. U. Smith, E. E. R. Tratman, A. P. Wenzell.

The work of your Sub-Committee for the current year has consisted, for the most part, of collaboration with the Joint Committee on Railway Sanitation. This latter committee is composed of representatives of the U.S. Public Health Service and of the American Railway Association.

The particular matter referred to your Committee has to do with coach yards and coach yard facilities, and your Committee has responded with helpful comments and suggestions in connection with a forthcoming Manual which the Joint Committee expects to issue, presumably through the A.R.A., when it has been perfected.

Appendix C

(4) PROVISIONS FOR PARKING AND GARAGE FACILITIES FOR PRIVATE AUTOMOBILES OF RAILWAY PASSENGERS AT PASSENGER TERMINALS AND WAY STATIONS

E. J. Beugler, Chairman, Sub-Committee; H. L. Ripley, J. R. W. Ambrose, Irving Anderson, H. M. Bassett, C. H. Blackman, W. A. Christian, E. H. Fritch, O. H. Gersbach, R. J. Hammond, T. H. Greene, John V Hanna, E. M. Hastings, E. T. Johnston, C. P. McCausland, C. H. Mottier, A. E. Owen, T. R. Ratcliff, H. M. Roeser, A. P. Wenzell.

The preliminary work of this Sub-Committee last year indicated that the matter was in a trial or transitory stage and that few companies had adopted any definite policy. Replies received from inquiries sent out this year to representative railroads showed general practice as follows:

(1) Way stations in suburban towns near large cities:

- (a) Where ample ground is available, patrons are permitted to park passenger cars during the day without charge and without any responsibility on the part of the railroad company;
- (b) Where ground space is limited, a charge is made to balance demand. Usually the concession is granted to a contractor for a consideration and under certain restrictions.

(2) Terminals or stations in large cities:

- (a) With limited ground area and a large number of commuters it is seldom practicable to make any provisions on the terminal grounds for parking. Private concerns generally provide parking nearby in connection with service stations.
- (b) Where the number of commuters is negligible, adequate parking for cars of railroad patrons is sometimes available on ground at or near the terminal, for instance, Kansas City.

(3) Other stations both small and large where passenger travel is relatively small. Here the use of company ground not otherwise occupied is generally free for patrons parking.

While the replies were more definite and showed increasing interest in the subject, still very few roads have a fixed policy. The matter is under observation and it is too early to determine the effects on railroad business. Several companies report their parking facilities as mutually satisfactory, and some state that special provisions are being made at new or reconstructed stations.

When the need has been demonstrated for provision of parking facilities at way stations and terminals, with satisfaction to the railroad patrons and directly or otherwise beneficial to the railways' operations, this Committee can take up the matter of passenger station yard design as affecting requirements with respect to space, location, approaches, grades, and other elements of design, and such studies are recommended for future work This report is submitted as information only.

Appendix D

(6) HUMP YARDS

R. J. Hammond, Chairman, Sub-Committee; J. R. W. Ambrose, Irving Anderson, C. E. Armstrong, J. E. Armstrong, N. C. L. Brown, H. F. Burch, W. F. Cummings, O. H. Gersbach, W. H. Giles, F. W. Grace, G. F. Hand, M. J. J. Harrison, E. M. Hastings, C. T. Jackson, E. T. Johnston, E. K. Lawrence, L. L. Lyford, C. P. McCausland, A. Montzheimer, A. E. Owen, T. R. Ratcliff, H. L. Ripley, H. M. Roeser, W. B. Rudd, W. C. Sadler, C. U. Smith, A. P. Wenzell, J. L. Wilkes.

To meet traffic requirements a yard should be able in peak periods to receive trains promptly upon arrival, perform any auxiliary service (such as icing, feeding and watering stock, etc.), switch the cars into their proper classifications without appreciable delay in the receiving yard, and dispatch these cars in their proper position in the designated outgoing trains in a minimum of time.

When the volume of traffic or other conditions justify a hump yard to meet these requirements (see Vol. 30, page 762) the yard layout should provide for a continuous movement of a draft of cars over the hump once it has been started, for the movement of the cars of the draft to their proper position on the different classification tracks without damaging impacts and for a minimum loss of time between humping successive drafts. Such a layout will result in the nearest possible approach to continuous humping.

(1) Studies

So large a proportion of the factors affecting efficient operation are local that each terminal must be studied independently to provide the proper design. The design must include the track layout and gradients of all parts of the terminal affecting economical and efficient operation of the hump.

(2) Track Layout

The receiving tracks should be designed not only to permit trains promptly to enter the yard but also to release road locomotives with minimum interference with hump operations.

The track arrangement between the hump and receiving tracks should provide for moving cars to a point close to the "crest" while other cars are being humped and permit the quick return of the humping engine to the receiving tracks.

The hump leads should be designed to direct the cars quickly into diverging routes with a minimum distance between the crest and furthest clearance point.

During the past few years there has been a decided trend toward designs which divide the classification tracks into groups of from two to eight tracks, each group served by a sub, or group lead. (See Vol. 31, page 781.) The use of lapped switches and short turnouts will assist in reducing the length of leads.

When the classifications tracks are used as departure tracks also, additional classification tracks should be provided to prevent interference with hump operations while a track is occupied by a train. Sufficient lead tracks should be provided at the outgoing end so that any doubling may be done without fouling the hump lead.

If separate departure tracks are provided they should be arranged so that "pull-down" engines may be operated without interfering with hump operations.

Caboose tracks should be so located, if possible, that cabooses may be dropped into them without the use of the hump engine, and where they will be readily available in making up outbound trains.

Ice house, stock pens, l.c.l. transfer, etc., should be so located that cars may be placed with minimum delay after arrival at the terminal and be readily accessible for switching or placement in outbound trains.

(3) Track Gradients

With the "rider" hump the prime requisite is a layout with gradients which will carry the cars into the classification tracks to couple and allow the return of the riders in a minimum of time. Motor cars are frequently used to reduce the time required for riders to return to the hump.

This has usually resulted in a layout with straight ladders each serving a varying number of tracks, with a steep incline to give high initial acceleration, the gradients below the hump being such as will maintain the speed to the coupling point. As riders were available to control the cars or cuts at all times little or no attention was given to individual car resistances.

However, the advent of car retarders, in lieu of riders, to control the speed of cars has made imperative the determination of proper gradients if a high classifying capacity is to be obtained and cars switched without excessive impacts.

To determine the proper gradients to be used under various conditions information as to individual car resistances is necessary. Your Committee has collected and studied a large number of such individual car resistance tests, and with the co-operation of the signal companies is making further investigations. While it is as yet unable to make final recommendations and specify the gradients to be used under all the various conditions from such data as are available, a method of determining gradients has been developed and is presented as information.

In determining the proper gradients, there are two basic conditions to be met:

(1) The heavy easy rolling car under the most favorable running conditions (hot weather, following wind, etc.)
(2) The light hard rolling car under the least favorable running conditions (cold weather, adverse winds, etc.).

Sufficient difference in elevation, or drop, must be provided from the crest of the hump to the clearance point of any classification track, so that the hard rolling car under adverse conditions will roll into clear on its classification track.

It is fundamental, however, that cars do not accelerate unduly after leaving the last retarder, if damaging impacts are to be avoided, thus the gradients that should be provided below the last retarder must be such as will result in very little, if any, acceleration of the easy rolling car under favorable conditions.

Thus the drop from the crest of the hump to the end of the last retarder should be "A" minus "B."

"A"—is the amount of drop required between the crest of the hump and clearance to insure the hard rolling car under adverse conditions not stopping short of clearance.

"B"—is the drop required from the end of the last retarder to clearance to insure that the easy rolling car under favorable conditions does not unduly accelerate.

The drop between the crest of the hump and the last retarder should be apportioned so that:

The hump gradients will quickly separate the cars or cuts at the crest to provide the spacing necessary for the free throwing of switches.

The gradients through the last retarder are sufficient to start an average rolling car which has been stopped in the last retarder.

As far as the gradients of the classification tracks themselves are concerned, your Committee believes that the gradients should be such that (exclusive of occasional exceptional cars) the maximum loaded car under favorable conditions should not accelerate.

At the departure end of the classification tracks a slight up-grade is desirable to decelerate cars, but should not be sufficient to cause cars to roll back.

After careful analysis of the various tests collected, your Committee suggests certain values to use in applying the principles enunciated above, but wishes to point out strongly that these values must be modified to meet local conditions, such as only empty or loaded cars, strong prevailing winds, extreme temperatures—but should, in the light of information and experience to date, be found desirable to be used with mixed traffic under average conditions.

Car Resistance on Tangent Track

From crest to end of last retarder (including switch resistance) 28 lb. per ton for hard rolling cars under adverse conditions, and 6 lb. per ton for easy rolling cars under favorable conditions.

From end of last retarder to clearance—18 lb. per ton for hard rolling cars under adverse conditions and 4.4 lb. per ton for free rolling cars under favorable conditions.

On classification tracks—4.4 lb. per ton for easy rolling cars of 70 tons gross weight and over—5 lb. per ton for easy rolling cars of less than 70 tons gross weight and 6 lb. to 8 lb. per ton for empties.

Curve Resistance Compensation

For hard rolling cars under adverse conditions .045 ft. drop per degree of central angle.

For easy rolling cars under favorable conditions .025 ft. drop per degree of central angle.

Gradients Through Last Retarder

0.8 per cent to 1.2 per cent, depending on the class of traffic.

(4) Scales

The location of scales on the hump will increase the distance between the crest of the hump and the clearance point of the classification tracks.

(5) Hump Facilities

The hump master's cabin, hump signal control, and other communication facilities should be located at the crest of the hump and on the right hand side.

Cars should be uncoupled on this side so that forward knuckle will be open, as any jar will generally close the rear knuckle.

(6) Retarder Towers

Towers should be located so that operators will have a clear view at all times of the cars they are controlling.

The control of switches and retarders should be distributed among the towers so that the work will be evenly apportioned among the operators. In allocating the work it should be remembered that the first tower controls all cars.

(7) Communication Facilities

Loud speaker telephone circuits between the hump and each retarder tower are essential.

Pneumatic tubes between the general yard office and strategic points will reduce time required in handling waybills, inspection lists, etc.

Teletype machines or pneumatic tubes between the yard office, the hump cabin and retarder towers, will permit handling switch lists promptly.

(8) Yard Lighting

Adequate yard lighting is always desirable, but is particularly necessary for the safe operation of a hump yard.

The lighting should be such that riders or retarder operators can at all times see the tracks on which cars are moving and the location of other cars on the classification track to which a car is being switched.

With retarder operation it is essential that the visibility be particularly good in the retarder zone.

Supplementary lights if necessary should be provided so that retarder operators may check car numbers and initials of cars passing their tower.

(9) Hot Oil System

During cold weather the application of hot oil to the car wheel journals will decrease the journal box resistances. The oil should be heated to a temperature of from 180 degrees to 190 degrees Fahr. and applied under pressure.

Drip boxes with hose connections should be located on each side of the hump track two or three car lengths in advance to the crest for this purpose.

(10) Flange Oilers

The use of flange oilers has a marked effect on car resistance, both in lowering the total resistance encountered and in decreasing the spread between resistances in the action of individual cars. Moreover, it introduces a valuable element of flexibility available to overcome in part the higher resistance encountered in winter weather.

(11) Summary

The group track arrangement with gradients as suggested will give a compact layout and provide for an economical car retarder installation.

It may, however, be operated as a rider yard, permitting the riders to leave the cars, after bringing them to safe coupling speed, at the clearance point, requiring only a minimum time per rider per cut.

Appendix E

(9) SCALES

M. J. J. Harrison, Chairman, Sub-Committee; J. E. Armstrong, A. Bousfield, A. W. Epright, E. D. Gordon, G. F. Hand, E. M. Hastings, H. O. Hem, E. K. Lawrence, J. L. Miller, A. T. Powell, T. R. Ratcliff, H. L. Ripley, H. M. Roeser, M. H. Starr, W. M. Wilson.

During the past year and under the assignment, "Scales Used in Railway Service," your Committee has given attention primarily to details intimately connected with the maintenance of accuracy of railway track scales. These details are now covered on pages 1031 to 1034, inclusive, of the 1929 Manual under the headings, "V—General Specifications for Master Scales" and "VI—Test Weight Cars."

The general specifications for master scales have been reviewed critically, as have the detailed performance records of existing master scales in the United States, a list of which was shown on page 405 of Volume 30 of the Proceedings. Your Committee has concluded that the matter relating to master scales now in the Manual is unsatisfactory, in that compliance therewith will not necessarily produce a scale, the performance characteristics of which conform to the modern conception of being satisfactory. Your Committee therefore proposes the deletion of the section referred to, and, if this recommendation be approved, further proposes to prepare a satisfactory specification and to present it at a later date.

During the past year, the pertinent sections of "Section VI—Test Weight Cars" were used by another organization, the National Scale Men's Association, in the preparation of a set of detailed specifications for such facilities. The attention of your Committee was invited to the completed detailed specifications, and your Committee examined them critically. It was agreed that the new specifications did, in fact, conform to the fundamental requirements set forth in our Manual, and that they had much merit, and consideration was given to recommending their endorsement by this Association. After due deliberation, however, it appeared that there were certain parts of the new specifications which should be passed on by the Mechanical Division of the American Railway Association. Therefore, before making any definite recommendation, steps were taken to secure the collaboration of that Division in this matter. Following conference with representatives of the Mechanical Division and other parties at interest, your Committee proposes to make appropriate recommendation.

A much discussed subject in the design of scales has been the value of the safe load which may be applied per linear inch of knife-edge. During the past year individual members of your Committee have done considerable in the way of investigating this subject. At the time of the preparation of this report, however, none of this work has reached the point where even a progress report may be made by the Committee. The work will be continued, however, and it is anticipated that a report of findings may be made available in the near future.

Conclusions

That the portion of the Manual on pages 1031 and 1032, under the heading, "V—General Specifications for Master Scales," be deleted, and that the balance of this report be received as information.

Appendix F

(10) BIBLIOGRAPHY OF RAILWAY STATIONS, YARDS, MARINE TERMINALS AND AIRPORTS

Compiled by E. E. R. Tratman.

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REPORT OF COMMITTEE XVI—ECONOMICS OF RAILWAY LOCATION

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*Resigned. †Deceased.

To the American Railway Engineering Association:

Your Committee respectfully presents herewith report covering the following subjects:

(1) Continue the study of economics of railway location as affected by the introduction of electric locomotives (Appendix A).

(2) Study and report on the extent train resistance is increased when trains are operating on flexible rails as compared with same operation with stiffer rails (Appendix B).

(3) Study and report on the proper size and character of field organizations for railway location and construction (Appendix C).

Action Recommended

(1) That Appendix A be received as information

(2) That Appendix B be received as information.

(3) That Appendix C be approved for publication in the Manual

Respectfully submitted,

THE COMMITTEE ON ECONOMICS OF RAILWAY LOCATION,

F. R. LAYNG, *Chairman.*

Bulletin 331, November, 1930.

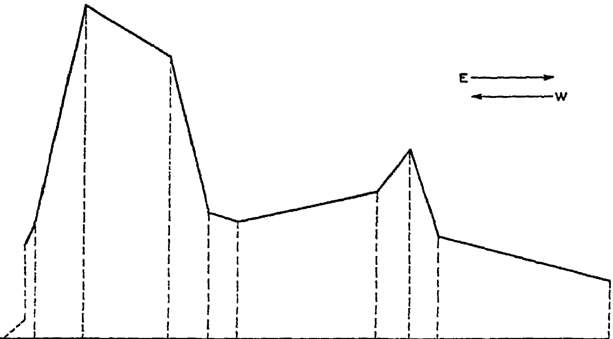
Appendix A

(1) ECONOMICS OF RAILWAY LOCATION AS AFFECTED BY THE INTRODUCTION OF ELECTRIC LOCOMOTIVES

F. E. Wynne, Chairman, Sub-Committee; S. E. Armstrong, H. H. Edgerton, C. P. Howard, E. E. Kimball, W. D. Wiggins, J. C. Wrenshall.

Last year a method for choosing an electric locomotive for a specified service was presented and printed as Appendix B of Committee XVI's report on pages 1233 to 1240 of the Proceedings for 1930. It also appears on pages 67 to 74 of the July, 1930, Supplement to Manual of 1929.

To illustrate the use of this method, we are now stating a problem in electric locomotive selection together with a solution.



SECTION	1	2	3	4	5	6	7	8	9
LENGTH-MILES	2.6	12.0	21.4	10.0	7.0	34.0	8.0	7.0	42.0
COMP. GRADE-EAST-%	1.13	1.99	.104	1.32	.091	.165	.586	1.28	.073
COMP. GRADE-WEST-%	.76	1.70	.304	1.46	.17	.024	.479	1 43	.153
MAXIMUM GRADE-%	1.21	2 11	1 25	1.45	.50	.20	.60	1.42	.90
MAXIMUM CURVE-DEG.	12.0	12 0	8.0	8.0	3 0	6.0	8.0	8.0	4.0
AVERAGE CURVE-DEG.	4.6	3.7	4.4	2.5	1.8	.80	1.4	2.1	90

FIG. 1.—CONDENSED PROFILE.

The Problem

Given:

The profile of a road to be electrified is shown in Fig. 1. The loaded movement is eastbound. The gross trailing train weight is 5000 tons, made up of 65 coal cars having an average loaded weight of 76.56 tons and one 23.6-ton steel caboose. The speed on the maximum grade eastbound is to be 15 miles per hour.

Westbound the train weighs 1500 tons and consists of 65 empties and one caboose.

The maximum curve occurs on the maximum grade and *allowance for curve resistance is to be made on the basis of slow speed operation at all

*See page 1260—(e')—(3") of the 1929 Manual.

times. Starting on this combined grade and curve at an acceleration rate of 0.1 mile per hour per second with a 30 per cent †coefficient of adhesion will be required. The 1.45 per cent maximum down grade eastbound is on a tangent.

Train resistance of cars is to be taken in accordance with the formula on page 1258 of the 1929 Manual. The resistance of locomotive weight on drivers is to be taken at 15 pounds per ton.

A motor-generator type of locomotive with characteristics as shown in *Fig. 2 is to be used. The locomotive efficiency when regenerating is to

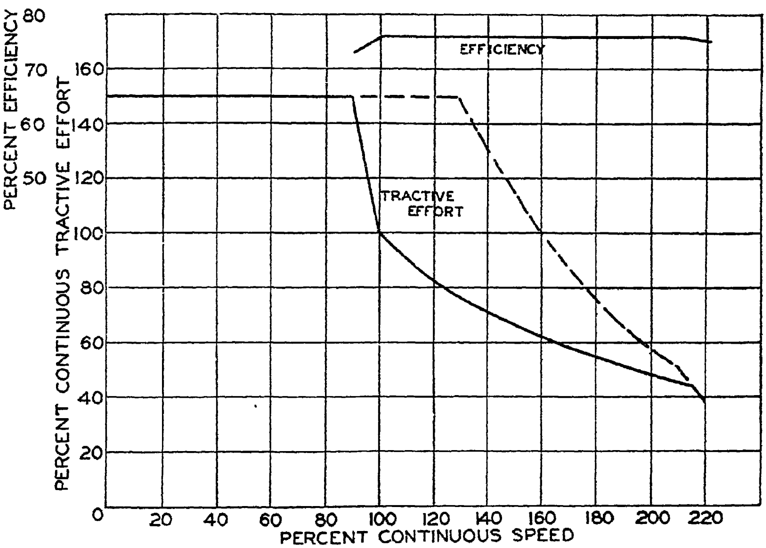


Fig. 2—Alternating Current Motor Generator. Solid Lines Show Normal Operating Range, Dotted Lines Show Permissible Range.

be the same as when motoring. Down-grade speeds are to be the same as up-grade speeds for the same per cent tractive effort.

Required:

(1) The total adhesive weight of locomotive to handle the 5000-ton train up the 12 miles of 1.99 per cent grade.

(2) The adhesive weight required east of the top of the grade, assuming the train to be held by regeneration on down grades.

*Same as Fig. 4, page 1237, of the 1930 Proceedings, and Fig. 4, page 71, of the July, 1930, Supplement to Manual of 1929

†See page 1264 of the 1929 Manual.

(3) Based on (1) and (2) select a type of locomotive unit and determine the number of units required east and west of the top of the grade.

(4) The continuous horsepower and tractive effort rating of the locomotive unit.

(5) The time required to run over the line.

(6) The electrical energy consumption for one eastbound trip, both gross and net.

(7) Check the locomotive type, speed and capacity for westbound movement.

The Solution

(1) The maximum grade eastbound is 2.11 per cent and is partly on curves of 12 deg. The allowance for this curvature at 0.04 per cent per degree is 0.48 per cent. Hence the combined grade and curve is equivalent to a 2.59 per cent grade. From page 1233 of the 1930 Proceedings, for starting,

$$W_D = \frac{(20G + 100\,a + R_T)\ (T + W_C)}{2000\,A_S - 20\,G - 100\,a - R_D}$$

W_D = locomotive adhesive weight (tons)
G = 2.59 per cent grade
a = 0.1 m.p.h.p.s. acceleration
R_T = 3.8 lb. per ton, train resistance
T = 5000 tons train weight
W_C = 0.33 W_D (from experience) idle locomotive weight
A_S = 30 per cent coefficient of starting adhesion
R_D = 15 lb. per ton, locomotive driver resistance.

Substituting these values in the formula,

$$W_D = \frac{[20\ (2.59) + 100\ (0.1) + 3.8]\ \ [5000 + 0.33\ W_D]}{2000\ (0.30) - 20\ (2.59) - 100\ (0.1) - 15}$$

and

W_D = 654 tons for starting up grade.

From page 1233 of the 1930 Proceedings, for running, there is no acceleration ($a = o$) and

$$W_D = \frac{(20G + R_T)\ (T + W_C)}{2000\,A_R - 20\,G - R_D} \text{ where}$$

A_R = 25 per cent coefficient of running adhesion *and the other symbols are the same as before.

Substituting,

$$W_D = \frac{[20\ (2.59) + 3.8]\ \ [5000 + 0.33\ W_D]}{2000\ (0.25) - 20\ (2.59) - 15}$$

and

W_D = 670 tons for running up grade. This weight of 670 tons on drivers is required since it is larger than the starting weight required; that is, in order not to exceed 25 per cent adhesion in running, the starting adhesion will be something less than the limit of 30 per cent

*See page 1264 of the 1929 Manual

The locomotive weight on non-driving axles,

$W_O = 0.33\ W_D = 0.33\ (670) = 221\ 1$ tons;

Say 220 tons for round numbers.

Then total locomotive weight for this service is $670 + 220 = 890$ tons.

(2) The maximum down grade eastbound is 1.45 per cent on a tangent. On down grades where the train is held by regeneration, the same formula for adhesive weight of locomotive under running conditions applies, remembering that the train and locomotive resistance values are negative since they act in opposition to the grade resistance.

$$W_D = \frac{(20\,G + R_T)\ (T + W_C)}{2000\,A_R - 20\,G - R_D}$$

$G = 1.45$ per cent grade
$R_T = -3.8$ lb. per ton, train resistance.
$R_D = -15$ lb. per ton, locomotive driver resistance.

Substituting,

$$W_D = \frac{[20\ (1.45) + (-3.8)]\ [5000 + 0\ 33\ W_D]}{2000\ (0.25) - 20\ (1.45) - (-15)}$$

and

$W_D = 264$ tons for running down grade.

Similarly on Section 7 eastbound, where the maximum grade is on a tangent,

$W_D = 229$ tons for starting up grade,

and

$W_D = 169$ tons for running up grade.

The adhesive weight of 264 tons is required for regeneration eastbound after passing the summit, although less would be sufficient for ascending the grade of section 7.

(3) The maximum adhesive weight required eastbound from the summit is 264 tons, while eastbound on section 2 it is necessary to have 670 tons on the locomotive drivers. These weights are practically in the ratio of 2 to 5, which indicates that a 2-unit road engine, with a 3-unit pusher from the western terminal to the summit, will fit the service requirements eastbound. Each unit will have $670 \div 5 = 134$ tons adhesive weight and $220 \div 5 = 44$ tons non-adhesive weight or a total weight of 178 tons. In a final design it is probable that this size and type of locomotive would be built most economically with the 2—8—2 wheel arrangement, having 67,000 pounds per driving axle and 44,000 pounds on each truck.

(4) For capacity the most severe demand occurs in ascending the 12 miles of 1.99 per cent grade of Section 2. Here the tractive effort required is $T.E. = [20\ (1.99) + 15]\ 670 + [20\ (1.99) + 3.8]\ [5000 + 220]$.

$T.E. = 264{,}300$ pounds.

At 15 miles per hour on this grade

$$HP = \frac{T.E. \times M.P.H.}{375}$$

Substituting:

$$HP = \frac{264{,}300 \times 15}{375} = 10{,}572 \text{ horsepower.}$$

As this 12 mile ascent at 15 miles per hour requires less than one hour the continuous rating may be exceeded.* However, the starting tractive

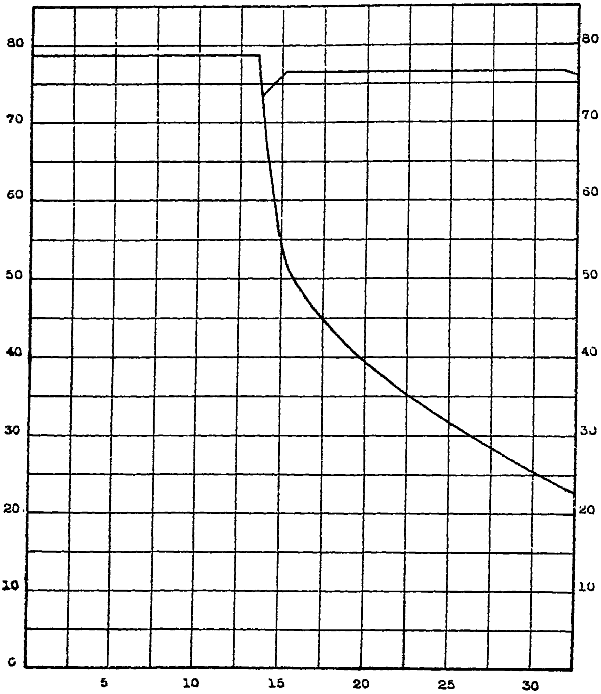


FIG. 3—ALTERNATING CURRENT MOTOR GENERATOR LOCOMOTIVE. CONTINUOUS RATING, 2120 H.P.

effort should be not more than 50 per cent greater than the continuous tractive effort. For starting on the maximum combined grade and curve,

$$T.E. = [20\ (2.59) + 100\ (0.1) + 15]\ 670 + [20\ (2.59) + 100\ (0.1) + 3.8]\ [5000 + 220]$$

$$T.E. = 393{,}900 \text{ pounds.}$$

This is 150 per cent of 262,600 pounds, which is less than the 264,300 pounds running tractive effort and the smaller value of tractive effort is suitable as the continuous rating of the locomotive. The running $T.E.$ of 264,300

*See page 1234, (7) of the 1930 Proceedings, and page 68, (7) of the July, 1930, Supplement to Manual of 1929.

pounds is 100.7 per cent of this continuous *T E.* of 262,600 pounds. From Fig. 2, the corresponding speed is 99 per cent of the rated speed. The speed on the grade was specified as 15 m.p.h.; hence, the rated speed is $15 \div 0.99 = 15.15$ m.p.h. and the continuous rated capacity of the locomotive is:

$$HP = \frac{262{,}600 \times 15.15}{375} = 10{,}615 \text{ horsepower.}$$

For round figures, we may use 10,600 horsepower, 262,200 pounds tractive effort at 15.15 miles per hour. This being in five units (2-unit road engine and 3-unit pusher), each unit rates 2120 horsepower continuously. From Fig. 2,† we can now construct Fig. 3 for this 2120 h.p. locomotive unit.

(5) To determine the time to make the eastbound run, it is necessary for each section to calculate the total tractive effort and read the corresponding speed from Fig. 3. From the length of each section and the speed on it, the running time on that section is found. It is convenient to tabulate these results as shown in the first eight columns of Table I. The total running time, Column VIII, is 6 hr. 1 min.

Additional time is required for stops and starts as determined by average conditions on the road. Assume 20 minutes preliminary time at the western terminal for the enginemen to start locomotive auxiliaries, couple to train and pump up air. Assume one stop of 30 minutes at the summit to cut off the pusher and meet a westbound freight, one stop of 10 minutes at the west end of section 6 to meet a westbound freight and one stop of 20 minutes at the west end of section 7 to permit an eastbound passenger train to pass.

The additional time for all starts may be taken as,

5 minutes leaving the west terminal,
4 minutes leaving the summit,
6 minutes entering section 6, and
4 minutes entering section 7.

Total 19 minutes additional for starts.

For drifting and braking before stops, the additional time may be taken as,

2 minutes at the summit,
3 minutes leaving section 5,
2 minutes leaving section 6, and
4 minutes entering eastern terminal.

Total 11 minutes additional drifting and braking time.

The total elapsed time between terminals then becomes—

6 hr. 1 min. + (20 + 30 + 10 + 20 + 19 + 11) min. or 7 hrs. 51 min.

(6) For section 1 the following* calculations give the electrical input to the locomotive,

$$O = \frac{(T.E. \times M.P.H.)\ T}{375} = \text{horsepower-hours output.}$$

where $T.E. = 163{,}000$ pounds tractive effort.
$M.P.H. = 24.15$ miles per hour speed.
$T = 0.108$ hour time.

† See page 1235, (10) of the 1930 Proceedings, and page 69, (10) of the July, 1930, Supplement to Manual of 1929.
*See page 1238, (14) of the 1930 Proceedings, and page 72, (14) of the July, 1930, Supplement to Manual of 1929.

Substituting,

$$O=\frac{(163{,}000)\ (24.15)\ (0.108)}{375}=1134 \text{ horsepower-hours.}$$

From Column IX of Table I the efficiency at this load is 76.5 per cent.

$$\text{Then } I_h=\frac{O}{E_t}=\text{horsepower-hours input}$$

where E_t = locomotive efficiency.

Substituting,

$$I_h=\frac{1134}{.765}=1482 \text{ horsepower-hours.}$$

In kilowatt-hours the input is

$$I_k=0.746\quad I_h=0.746\ (1482)=1106 \text{ kilowatt-hours.}$$

These values and those for the other sections, similarly computed are tabulated in the last three columns of Table I.

It should be noted in regeneration that the input is at the rail and the output is at the trolley; hence,

$$I_h=\frac{(T.E \times M.P.H.)\ T}{375} \text{ horsepower-hours input,}$$

$$O_h=I_h \times E_t \text{ horsepower-hours output,}$$

$$\text{and } O_k=0.746\ O_h \text{ kilowatt-hours output.}$$

Summation of the values in Column XII, Table I, shows that the gross electrical input for running eastbound is $I_R = 18{,}009$ kilowatt-hours, the regenerated locomotive output is 2960 kilowatt-hours, and the net input to the locomotive is $I_N = 18{,}009 - 2960 = 15.049$ kilowatt-hours.

For † starts the accelerating tractive effort (Fig. 3) is 78,800 pounds per locomotive unit up to 13.5 miles per hour, at which point the efficiency is 73 per cent. The accelerating input rate is

$$HP_S=\frac{(78{,}800)\ (13.5)}{(375)\ (0.73)}=3886 \text{ horsepower per locomotive unit.}$$

The time for each start is given in the solution of (5). Leaving the western terminal 5 locomotive units are used; at all other starts there are 2 locomotive units. The total accelerating input then becomes

$$I_S=\frac{5\ (3886)\ 5}{60}+\frac{2\ (3886)\ \ (4+6+4)}{60}$$

$$=3432 \text{ horsepower-hours.}$$

$$=2560 \text{ kilowatt-hours.}$$

During* drifting, braking and standing the locomotive auxiliaries are taking power at a rate $HP_a = K\ (HP_C)$ horsepower where HP_C = input

†See page 1239, (15) of the 1930 Proceedings, and page 73, (15) of the July, 1930, Supplement to Manual of 1929.

*See page 1239, (16) of the 1930 Proceedings, and page 73, (16) of the July, 1930, Supplement to Manual of 1929.

to locomotive at its continuous rating and $K = 0.09$ for a motor-generator type of locomotive. For each locomotive unit

$$HP_C = 2120 \div 0.765 = 2771 \text{ horsepower}$$
$$\text{and } HP_a = 0.09\ (2771) = 250 \text{ horsepower}$$

The total input for auxiliaries is

$$I_a = \frac{5\ (250)\ 20}{60} + \frac{2\ (250)\ (30 + 10 + 20 + 11)}{60}$$
$$= 1009 \text{ horsepower-hours}$$
$$= 753 \text{ kilowatt-hours.}$$

Therefore, the gross input for the entire trip is,

$$I_G = I_R + I_S + I_a$$
$$= 18{,}009 + 2560 + 753$$
$$= 21{,}322 \text{ kilowatt-hours;}$$

and the net input for the entire trip is the difference between the gross input and the regenerated energy; that is,

$$I_N = 21{,}322 - 2960$$
$$= 18{,}362 \text{ kilowatt-hours.}$$

(7) From inspection of the profile it is evident that the suitability of a two-unit road engine for hauling 1500 tons trailing westbound will be determined by the requirements when motoring up the 1.45 per cent grade on section 4 and when regenerating down the 2.11 per cent grade on section 2.

The train resistance of 1500 tons, made up of 65 empties and 1 caboose, from the Manual formula is 7.55 pounds per ton.

On section 4 the running tractive effort is

$$T.E._R = 20\ (1.45)\ (1500 + 356) + 15\ (268) + 7.55\ (1500 + 88)$$
$$= 69{,}833 \text{ pounds and the speed is 22.5 miles per hour.}$$

For starting,

$$T.E._S = 69{,}833 + 10\ (1500 + 356)$$
$$= 88{,}400 \text{ pounds.}$$

These values are within the continuous capacity of the 2-unit locomotive.

On section 2, the holding tractive effort on the maximum grade is

$$T.E._H = 20\ (2.11)\ (1500 + 356) - 15\ (268) - 7.55\ (1500 + 88)$$
$$= 62{,}314 \text{ pounds.}$$

This is within the continuous capacity of the 2-unit locomotive. Hence, the road locomotive required for the eastbound loaded movement is sufficient for the westbound empty movement.

Table I

I	II	III	IV	V	VI	VII Z	VIII	IX Z	X V	XI V	XII V
Sec.	Length Miles	Avg. Comp. Grade Per Cent	*Total Tractive Effort Pounds	No. of Loco. Units Working	Tractive Effort Per Loco. Unit Pounds	Speed Miles Per Hour	Time Hours	Loco. Eff. Per Cent	Output From Loco. HP. Hours	Input To Loco. HP. Hrs.	Input To Loco Kw. Hrs.
1	2.6	+1.13	163,000	5	32,600	24.15	.108	76.5	1,134	1,482	1,106
2	12.0	+1.99	264,300	5	52,860	15.0	.800	76.0	8,458	11,128	8,301
3	21.4	—0.104	12,200	2†	6,100	25.0§	.856	50.0§	697	1,394	1,040
4	10.0	—1.32	—118,000	2	—59,000	14.6	.685	75.2	—2,367	—3,147	1,765
5	7.0	—0.091	13,600	1‡	13,600	30.0§	.233	69.8§	254	363	271
6	34.0	+0.165	41,000	2	20,500	33.3	1.021	75.0	3,717	4,956	3,697
7	8.0	+0.586	86,100	2	43,050	18.2	.440	76.5	1,839	2,404	1,793
8	7.0	—1.28	—113,800	2	—56,900	14.7	.476	75.5	—1,602	—2,123	1,195
9	42.0	—0.073	15,500	1‡	15,500	30.0§	1.400	71.9§	1,736	2,414	1,801
	144.0	Totals and Averages				23.9	6.019				

*Negative sign indicates net retarding effort of locomotive regenerating.
†Although average duty is very light, both units of road engine are used on account of maximum grade.
‡Although the road engine comprises 2 units, most efficient operation is secured by using only one unit at such light loads
§Assumed speed restrictions on account of maximum grade and curves; corresponding efficiencies calculated.
Z Read from Fig. 3. V Negative sign indicates regenerated energy.

Appendix B

(2) STUDY AND REPORT ON THE EXTENT TRAIN RESISTANCE IS INCREASED WHEN TRAINS ARE OPERATING ON FLEXIBLE RAILS AS COMPARED WITH THE SAME OPERATION WITH STIFFER RAILS, COLLABORATING WITH COMMITTEE IV—RAIL, AND COMMITTEE XXI—ECONOMICS OF RAILWAY OPERATION

J. C. Wrenshall, Chairman, Sub-Committee; L. G. Aten, H. A. Dixon, T. H. Lantry,* Fred Lavis, William Michel, J. A Noble, H. M. Stout, Walter Loring Webb.

The subject assigned has been studied and data collected, but the same is not in suitable form for presentation to the Convention. The members, however, desire to call attention to the fact that in 1902 the late Dr. P. H. Dudley conducted stremmatograph tests of rails on the New York Central & Hudson Railroad, the more pertinent pamphlet describing mechanical experiences with limber and stiff rail sections. As far as we can ascertain this was the first definite effort to determine the relative values of the heavier rail sections and it was his thought that the heavier loads had increased the expended tractive effort to such an extent that it had become a decided factor in augmenting the wheel contact pressures, bending moments, and subsequent stresses in the rails as girders, which seems to indicate that the heavier sections were not only essential for the safe movement of the then and subsequent rapidly increasing axle loads, but were factors in decreasing train resistances in operation due to less flexibility. In other words, the mechanical properties of the design of the larger sections rendered the track structure stiffer and stronger even when carrying the larger wheel loads.

At the March, 1930, Convention a very elaborate and instructive paper was presented by Chief Engineer A. N. Reece, of the Kansas City Southern Railway, on "Economical Selection of Rail," and under Section 19 of that paper we find a description of train resistance measured upon rails of varying weights per yard, and the conclusions reached were that the heavier rail sections were productive of less resistance than the lighter sections. (See pages 1495 to 1553, inclusive, Vol. 31, 1930 Proceedings, A.R.E.A.)

In the report of the Roadway Committee, pages 221 to 231 of Vol. 30, A.R.E.A. Proceedings, will be found a report by Paul Chipman, Office Engineer of the Pere Marquette Railway Company, wherein he describes the lesser train resistances that were developed in test runs over tracks of greater rigidity than on tracks with flexible rails. This report is very complete and indicates the benefits to be derived from the reduction of train resistance due to the rigidity of the rail. No matter how the rigidity may be obtained, either by stiffer and stronger under support, or by the use of heavier rail sections with great girder strength, the result will be the same as regards train resistance in that with the less wave action or undulation there will be less resistance, and the general opinion appears to be that the better results are obtained from the more rigid rail which seems to be rapidly coming into general use.

*Deceased.

Appendix C

(3) STUDY AND REPORT ON THE PROPER SIZE AND CHARACTER OF FIELD ORGANIZATIONS FOR RAILWAY LOCATION AND CONSTRUCTION

Fred Lavis, Chairman, Sub-Committee; F. L. Batchelder, J. L. Campbell, C. E. Day, A. B B. Harris, T. C. Macnabb, P. E. Thian, Walter Loring Webb

LOCATION

Reconnaissance

Reconnaissance sufficient to determine the general route, and principal governing points should precede the organization of survey parties and attention is called to the use of the aeroplane and stadia surveys in this connection, especially in unmapped territory.

GENERAL CONSIDERATIONS

(1) The personnel of field organizations for railway location and construction varies greatly according to conditions as to

- (a) Character of country, flat or mountainous, prairie land, dense forests, or extensive swamps;
- (b) Distance from "civilization" or sources of supply;
- (c) Presence (or absence) of the special conditions which have made some surveys particularly difficult, arduous and even dangerous;

(2) For purposes of analysis, the personnel should be divided into two classes—the technical and the non-technical men. The technical men include the leader or "chief-of-party," the instrument men, and all those who must have technical qualifications and training. The non-technical men include cooks, teamsters, axemen, and all those whose duties can be performed by untrained men, who can frequently be recruited locally.

(3) The larger part of the variations in personnel apply to the non-technical men. The personnel list of these men will vary according to circumstances, and the list may sometimes be increased or diminished as the survey progresses, if circumstances warrant it and new recruits are readily obtainable when desired.

(4) The chief-of-party should have no routine duties to perform. He should be free to "keep his eyes open" and to spend his time in planning the work and in studying the modifications of the original plan which the additional information developed by the survey show to be desirable or necessary.

(5) Since the progress of the survey depends on having each man working to the proper limit of his capacity, so that the party as a whole is not delayed waiting for an overloaded man to do his work or cause him to slight his work in order to keep up with the party, much depends on a proper balance of the personnel. For example, a large party whose daily or hourly cost, in salaries and expenses, is very large, might be delayed by an insufficiency of axemen, the cost of the extra axemen being only a small part of the cost of the delay of the whole party. This general principle will explain the necessity of adding to the party some men who are frequently omitted from such lists with the mistaken idea of "economy." For example, a "recorder" who should attend the transitman, particularly on preliminary surveys and especially when the stadia method is used, will permit the transitman to devote his entire attention to his transit, avoid errors or inaccuracies due to a too hasty reading of angles, and the recorder will be able to produce more complete, legible and accurate notes for the use of the draftsman who plots the notes. One of the duties of the chief-of-party should be to watch the balance of the working force, and maintain the steady regular progress of the survey. A slight excess of cheap, non-technical men is less expensive than delays of the whole party.

PRELIMINARY STADIA SURVEYS

(6) Except in timbered country, the stadia method of obtaining the requisite topography, on which to base the "paper location," is often more rapid and efficient than the method of obtaining topography by cross-sections with a hand level. Some of the unpopularity of the stadia method is due to lack of familiarity with some of the refinements of the method (using stadia slide rule, etc.) by which the work is facilitated and made more rapid and accurate. Whenever a "first" and "second" preliminary survey is made (perhaps only for short difficult sections) the first survey may preferably be made by stadia. The stadia, however, is usually only applicable to continuously open country.

(7) The personnel for stadia survey should be: chief-of-party, transitman, recorder, and two, three or four rodmen. When well organized and trained, four rodmen can be kept literally on the run, the number of "shots" in a day's work will be correspondingly increased, the information obtained will be more complete and the progress of the party more rapid. A draftsman at the temporary field headquarters should each day completely plot the previous day's work. Levels should be controlled and checked by a regular level party and one or two axemen and other non-technical men as conditions require.

(8) The plane table may be used as an adjunct of the stadia survey and also for taking topography on suitable terrain if the personnel is familiar with its use and climatic conditions are such that its use will not interfere with the general progress of the survey.

The following is suggested for the make-up of maximum and minimum parties for location:

MAXIMUM LOCATING PARTY

1 Chief-of-Party.
1 Office Draftsman.

Transit Party
1 Transitman.
1 Levelman.
2 Flagmen.
2 Chainmen.
2 Axemen or More*

Topography Party
1 Topographer.
2 Rodmen.

Land Line Party
1 Instrumentman.
1 Flagman.
1 Chainman.
1 Axeman or More.*

Conveyance and Subsistence
1 Cook.
1 Flunkey.

If Automobile Can be Used
1 Light Truck with Shallow Bed.
1 Light Automobile.

Where Teams Have to be Used
2 Two-Horse Teams and Wagons.
1 Saddle Horse.
1 Complete Camp Outfit to accommodate number of men in party.

---

*Number of axemen vary with character of country and in all cases should be left to the judgment of the Chief-of-Party.

*Number of axemen vary with character of country and in all cases should be left to the judgment of the Chief-of-Party.

MINIMUM LOCATING PARTY

1 Chief-of-Party.
1 Instrumentman
1 Rodman.
2 Chainmen.
2 Axemen or More.*

Conveyance and Subsistence

2 Light Automobiles.
Party stay at hotel or boarding house.

CONSTRUCTION

On Construction, a Division should cover about five (5) residencies, the Division Headquarters consisting of:

Division Engineer.
Office Engineer.
Assistant Office Engineer.
Clerk and Stenographer.

In certain parts of the world a doctor and complete medical outfit may be attached to Division Headquarters and special provision may have to be made for distribution of supplies of all kinds.

Residencies will usually be about 10 miles in length, the personnel varying with the character of the work. (In some cases the personnel may be the same on all residencies and the length of the residency varied in accordance with the character of the work.)

For residencies 10 miles in length the following is suggested:

Light Work

Resident Engineer.
Instrumentman.
2 Rodmen.
1 Chainman.
1 Axeman (stakeman).

Heavy Work (Including Tunnels and Heavy Bridges)

Resident Engineer.
1 Office Engineer.
3 to 4 Instrumentmen.
3 to 4 Rodmen.
3 Chainmen.
3 Axemen (stakemen)

Necessary inspectors for masonry, steel or timber bridges, tunnels, Resident Engineer and light trucks or wagons for rest of party.

Cooks and cook outfits if required.

Necessary inspectors for masonry, steel or timber bridges, tunnels, buildings, water supply, etc.

*Size of parties governed by local conditions, ruggedness of country, length of line and time in which survey is to be completed.

REPORT OF COMMITTEE III—TIES

W. J. Burton, *Chairman;*
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W. R. Ballord,
R. S. Belcher,
M. S. Blaiklock,
W. C. Bolin,
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C. W. Campbell,
E. E. Chapman,
H. R. Clarke,
S. B. Clement,
R. L. Cook,
E. L. Crugar,
H. R. Duncan,
C. W. Greene,
R. S. Hubley,
W. M. Jaekle,
*P. B. Jeffries,
J. E. King,
C. S. Kirkpatrick,
F. C. Krell,
F. D. Lakin,

John Foley, *Vice-Chairman;*
M. F. Longwill,
M. J. McDonough,
H. C. Munson,
L. T. Nuckols,
W. C. A. Palmer,
L. G. Pastor,
J. H. Reeder,
L. J. Riegler,
J. H. Roach,
S. S. Roberts,
S. Rodiguez,
S. E. Shoup,
L. L. Tallyn,
E. H. Thornberry,
H. M. Tremaine,
J. A. Vardon,
Harry Weightman,
J. W. Williams,
K. G. Williams,
W. W. Wysor,
R. C. Young,

Committee.

* *Died October 13, 1930.*

To the American Railway Engineering Association:

Your Committee respectfully presents herewith report covering the follow ing subjects:

(1) Revision of Manual.

(2) Anti-splitting devices (Appendix A).

(3) Extent of adherence to the Standard Tie Specifications (Appendix B)

(4) Substitutes for wooden ties (Appendix C).

(5) Tie renewal averages per mile of maintained track and securing dat from the Bureau of Railway Economics and the reports of the Interstate Com merce Commission (Appendix D).

(6) Methods and practices for proper seasoning of ties, with particula reference to increasing the service life (Appendix E).

(7) Extent, if any, to which decay is permissible in ties for treatment the various forms of such decay and proper methods for detecting it. (N report this year).

(8) Comparison of ties renewed per maintained mile with proper adjust ment for rate of application of treated ties since the beginning of their use an for traffic, using the approved traffic unit. (Appendix F).

The Committee regrets the passing of one of its members, Mr. P. B Jeffries, who died on October 13, 1930. Mr. Jeffries was an active worke whose advice and aid will be missed.

Bulletin 332, December, 1930.

Action Recommended

(1) No revision of the 1929 Manual, as supplemented by Bulletin 327, is proposed.

(2) That the recommended practice in accordance with Appendices A and E be added to the Manual.

(3) That the reports contained in Appendices B, C, D, and F be received as information.

Respectfully submitted,

THE COMMITTEE ON TIES,
W. J. BURTON, *Chairman.*

Appendix A

(2) ANTI-SPLITTING DEVICES

E. L. Crugar, Chairman, Sub-Committee; R. S. Belcher, C. W. Campbell, E. E. Chapman, H. R. Clarke, C. W. Greene, John Foley, R. S. Hubley, F. D. Lakin, L. T. Nuckols, L. J. Riegler, K. G. Williams.

Your Committee has heretofore made progress reports upon certain shapes of anti-splitting devices applied to ties undergoing the process of natural seasoning. The result of this test indicates that all three shapes of iron, viz., the "C", "S" and "Saf-Tie", when properly applied, will meet the requirements.

An examination of the anti-splitting devices now in use by different railroads indicates a variation in the thickness of the material used, and in other dimensions. The Committee has heretofore pointed out that an iron of sufficient stiffness to permit driving into the hardest woods is of sufficient strength to withstand seasoning stresses. An iron of greater thickness will unnecessarily displace wood which may cause further checking to develop and somewhat defeat the purpose for which the iron was applied. The Committee, therefore, recommends that the thickness of the iron be not heavier than 13 gage.

A double bevel edge is recommended for the reason that a greater area of full contact between the iron and the wood fiber is obtained than is the case with the single bevel type.

Two sizes of anti-splitting irons are recommended: one size with 5-inch over all dimension for ties of Sizes 0, 1, 2 and 3; and one size with 6-inch over all dimension for ties of Sizes 3A, 4, 5 and 6.

Conclusions

1. All hard or broad leaved woods are subject to checking and should have anti-splitting devices applied.

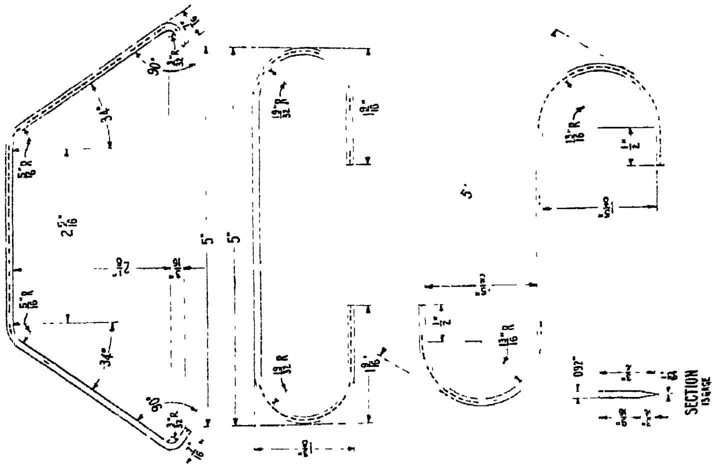
2. Anti-splitting devices should be applied prior to or at time the ties are delivered to the yard and stacked for seasoning.

3. Anti-splitting devices should be so placed as to cross at right angles the greatest possible number of radial lines of the wood.

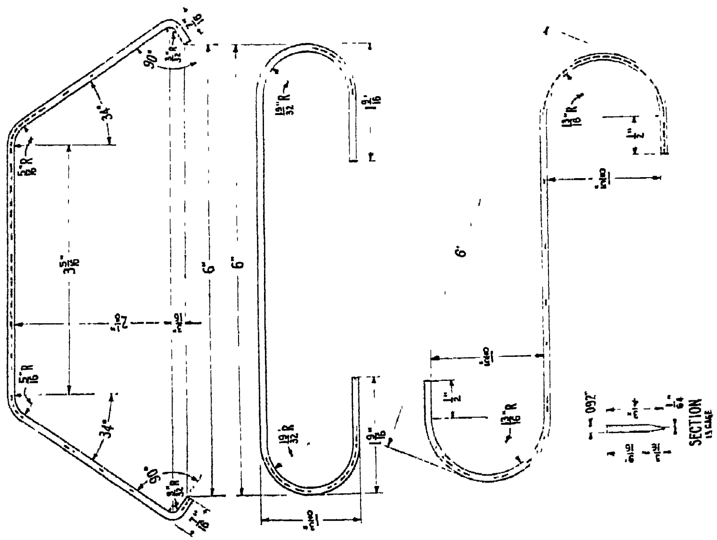
4. Shape and size: (See drawings)

5. Anti-splitting irons shall be made from open-hearth new billet steel of a chemical composition which shall be within the following limits:

Carbon	.25 to .35
Manganese	.40 to .60
Phosphorus	.05 or less
Sulphur	.05 or less
Copper	.20 or more



For Ties of Sizes 0, 1, 2 and 3



For Ties of Sizes 3A, 4, 5 and 6

Appendix B

(3) EXTENT OF ADHERENCE TO STANDARD TIE SPECIFICATIONS

John Foley, Chairman, Sub-Committee; M. S. Blaiklock, J. F. Burns, C. W. Campbell, S. B. Clement, R. L. Cook, C. W. Greene, W. M. Jaekle, *P. B. Jeffries, J. E. King, F. D. Lakin, M. F. Longwill, M. J. McDonough, H. C. Munson, L. T. Nuckols, J. H. Reeder, S. E. Shoup, E. H. Thornberry, J. W. Williams, K. G. Williams.

* Deceased

The low demand and curtailed production which characterized the cross-tie industry in 1929 continued throughout 1930, with local exceptions where railroads did not take positive action to restrict the receipts of the extra ties which are always produced when general business is depressed. In consequence there prevailed the lack of competition which provided extended time for the practice of adherence to accepted standards in inspection work. Not only did the railroads more generally accept only standard ties, but the contractors also more generally rejected sub-standard ties, with the result that the ties in existing stocks on the whole are nearer standard than they have ever been.

Examinations were made by the Committee as a whole and by individual members of 7 lots of ties, totaling 2,000,000, accepted by 15 railroads. Two of the lots looked over comprised 500,000 hardwoods, mostly oaks, produced in Illinois and Kentucky, and represented the inspection of two railroads which do not print specifications in conformity with the standard. One railroad designates as "2nd Class" a Size 2 tie (6 inch by 7 inch) which is 8 feet long, and also as "2nd Class" a Size 4 tie (7 inch by 8 inch) which is 8 feet 6 inches long. Under its system a "1st Class" tie may be either 6 inch by 8 inch or 7 inch by 9 inch, depending on whether it is 8 feet or 8 feet 6 inches long. The other railroad designates as "No. 5," ties which are Size 4 and Size 3 in the standard specifications. The differences in the size specifications of these two railroads and the lack of any superiority in the ties accepted by them over those accepted under the standard specifications gave the Committee reasons for regarding these departures from the standard as inadvisable, unnecessary, and not providing sound bases for changes in the standard.

The 13 railroads whose 1,500,000 ties in lots of 15,000 to 400,000 were examined at 5 points of concentration, obtained them in Louisiana, Oklahoma, and Texas. These ties were gum, oak, and pine. They had been accepted under the A.R.E.A. or the U.S.R.A. specifications. In several cases, they are the ties of railroads whose inspection was deplored in the report of this Committee in 1926. It is a satisfaction to record the remarkable improvement since then. The 1930 work resulted in ties no longer distinguished by decay and disregard for dimensions. Such unsound ties as are present evidently were accepted in error. Poor manufacture has not been eliminated to the same extent as in some sections of the country, and ties accepted as Size 1 which should have been Size 0 are numerous. However, the changes from former laxity of inspection is so striking as to reflect credit on all concerned.

At all seasoning yards where railroad stocks were examined, ties accumulated by contractors were available in unusual quantities as a result of the poor demand for them. These ties had been accepted in accordance with

the standard specifications of the National Association of Tie Producers, which are identical with those of the American Railway Association, and the inspection was in general such that railroads could rely on it to an extent not to be thought of before the American Standard specifications were adopted in 1926. If both the contractors and the railroads continue to reject the ties which are not acceptable under the standard specifications, their manufacture will soon cease. Bowed, crooked, decayed, split, and undersized ties will not be a problem where their production is not encouraged by reckless inspection or by the acceptance of defective ties as so-called serviceable culls or usable rejects.

The long-sustained extreme heat of the summer of 1930 split ties worse than is usual during the seasoning preparatory to preservative treatment. Where anti-splitting devices had not been applied before the ties were stacked, the loss in some sections was extreme. Such damage subsequent to their acceptance should not be overlooked in considering the extent of adherence to specifications when the ties were inspected as purchased.

There is evidently a wider appreciation of the loss from decay during overlong storage before preservative treatment, for at the wood-preserving plants visited hundreds of thousands of ties were creosoted during 1930 when they were sufficiently seasoned, even though they could not be consumed and had to be held for use in 1931.

Some railroads which had been using the specifications of the United States Railroad Administration or other slightly non-standard version of their own changed to the American Standard during 1930.

Appendix C

(4) SUBSTITUTE TIES

S. B. Clement, Chairman, Sub-Committee; S. V. Ardagh, M. J. McDonough, L. J. Riegler, E. H. Thornberry, W. W. Wysor.

REPORTS FROM RAILWAYS MAKING TESTS OF SUBSTITUTE TIES

Atlanta and West Point Railroad

Reported by S. R. Young, Assistant Chief Engineer.
Date—June 27, 1930.
Kind—Duke Reinforced Cross-Tie.

The ties originally installed are all reported as still in the track. No new installations have been made.

Bangor and Aroostook Railroad

Reported by P. C. Newbegin, Chief Engineer.
Date—June 9, 1930.
Kind—Maine Concrete.

There has been no change in the condition of these ties since the report of a year ago.

Bessemer and Lake Erie Railroad

Reported by F. R. Layng, Assistant Chief Engineer.
Date—October 23, 1930.
Kind—Brown Concrete (Casey).

Fifteen hundred Brown concrete ties of the same type as installed on the Pennsylvania Railroad and reported in Vol. 30, were installed in the southbound main track just south of the Allegheny River bridge near Oakmont, Pa., in May, 1930. Part of these ties are on three degree curve and part on tangent. The grade is ascending 0.6 per cent to the south. The ties weigh about 650 pounds each. Track is ballasted with 2½ inches blast furnace slag on solid and well drained roadbed. Rail is 130 pound and ties are spaced 18 to 33 ft. rail.

Delaware and Hudson Company

Reported by H. S. Clarke, Engineer Maintenance of Way.
Date—June 10, 1930.
Kind—Dalton.

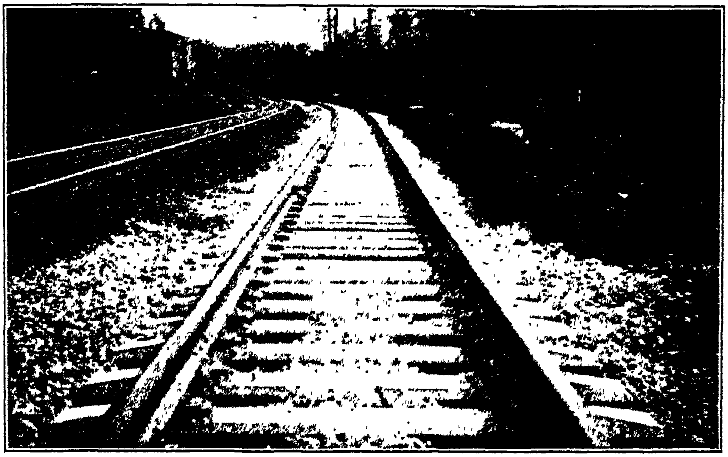
All ties are reported as working out excellently, and the tie plant installed for making the ties is working to capacity of approximately 80 ties per day. All ties manufactured are installed under a regular budget plan.

Duluth and Iron Range Railroad

Reported by E. H. Dresser, Vice-President and Chief Engineer.
Date—October 22, 1930.
Kind—Carnegie and Hatch.

The last report showed 1045 of the Carnegie Steel ties in track. Recent inspection shows this number to have been reduced to 937.

Seven of the Hatch ties are still in track but all of these are in a more or less damaged condition.



Brown Ties on Bessemer and Lake Erie Railroad

Duluth, Missabe and Northern Railway Company

Reported by E. H. Dresser, Vice-President and Chief Engineer.
Date—June 11, 1930.
Kind—Carnegie and Kimball.

A number of the Carnegie ties have been removed from track during the year, but the Kimball ties are all in place and giving good service.

Elgin, Joliet and Eastern Railway

Reported by F. H. Masters, Assistant Chief Engineer.
Date—October 22, 1930.
Kind—Bates and Carnegie.

Of the 62 Bates concrete ties installed in 1912 near Whiting, Ind., 60 remain in service at the point of original installation. Two ties were removed in June, 1930, on account of the tie and reinforcing rods between the two concrete blocks having rusted through, thus separating the two concrete blocks which form the tie. The concrete in one of these ties was very badly cut or shattered under the rails but the concretě in the other tie was in very good condition.

Statement Showing Carnegie Steel Switch Ties and Steel Cross-Ties in Tracks on July 1, 1930.

Year	Lin. ft. steel sw. ties laid in Renewals	Lin. ft. of steel switch ties taken up account of Renewals	Lin. ft. of steel switch ties laid in Construction	Lin. ft. of steel sw. ties taken up account track retired
1912	30452		5580	
13	196333		11527	430
14	142939		5135	
15	58314		2023	1615
16	17856	10	7120	16498
17	3789	1907	8623	17340
18	4511	3006	6564	5453
19	6483	526	1582	1582
20	575	22737	2588	2774
21	4712	24855	717	4744
22	241	21903	444	527
23	846	19451		
24	2300	18124	441	1394
25	180	33700		2271
26	1708	37098	255	2550
27	0	142954	2004	945
28	0	77891	0	0
29	0	17794	0	0
Jan. 1st to June 30, 1930	0	798	0	401
Total	471239	422754	54603	58524

Linear feet of steel switch ties laid in Renewals.....................471239
Linear feet of steel switch ties laid in Construction.................. 54603

525842
Linear feet of steel switch ties taken up account Renewals............422754
Linear feet of steel switch ties taken up account Tracks Retired....... 58524

Total 481278

Linear feet of steel switch ties in track July 1, 1930................. 44564

Carnegie Steel Cross-Ties

Number of steel cross-ties laid in track	15514
Number of steel cross-ties taken up	11505
Number of steel cross-ties in track July 1, 1930	4009

Steel cross-ties renewed as follows:

Year	*Number*
1916	50
1917	260
1918	182
1919	453
1920	306
1921	1165
1922	641
1923	2620
1924	1341
1925	262
1926	550
1927	2399
1928	1276
1929	0
1/1/30 to 7/1/30	0
Total	11505

Long Island Railroad

Reported by T. J. Skillman, Chief Engineer, Pennsylvania Railroad.
Dated—August 8, 1930.
Kind—King Foreign.

All ties removed during year due to failure.

Los Angeles Railway

Reported by B. J. Eaton, Engineer Way and Structures.
Date—June 10, 1930.
Kind—McDonald Concrete.

All of the ties are yet in track.

Pennsylvania Railroad—Eastern and Central Regions

Reported by T. J. Skillman, Chief Engineer.
Date—August 8, 1930.
Kind—Riegler, Snyder, Brown, Silver and Willis.

Riegler—One tie removed on account of disintegration. Concrete spalled off on six ties, at the ends or under rails. 12 clips out of 112 are loose and cannot be tightened unless bolts are renewed. Eight ties are in good condition. They have been in heavy service, high speed tracks for 22 years.

Snyder Composite—695 ties were removed during the past year on account of failure of steel shell and crushing of concrete. A number of clips are missing and many bolts are loose and rusted so that they cannot be tightened.

Brown Concrete (Casey):

Aspinwall, Pa.—Two ties were removed during the year, and 20 more should be removed due to crumbling. These ties are of the earlier design and are in rather poor condition.

Hays, Pa.—Ten ties were removed in 1928. Balance in fair condition, except that the wooden plugs have been spike killed due to regaging.

Monongahela, Pa.—None of the ties have been removed but 25 show signs of disintegration.

Wilkinsburg, Pa.—One tie was removed due to disintegration.

Pitcairn, Derry, Conpitt Jct., and Tunnelton, Pa.—All ties are in good condition except 60 which are broken at one end from three to six inches.

Bellwood, Pa.—A total of 261 ties were removed during the year due to failure of concrete. Of the remainder, 72 are cracked through, 48 are spalled and crushed under the rails, and 137 have the ends broken off at the reinforcing steel.

Highspire, Pa.—59 ties were removed during the year due to failure of concrete. Of the balance in track, 33 are cracked through, and 25 are spalled and crushed under rails.

M. P. 31, A. & S. Branch—78 ties removed during the year due to failure of concrete. Of the balance in track, 11 are cracked through, 9 are spalled and crushed under rail, and 58 have been damaged by wreck.

Haines, C. & P. D.—47 ties were removed during the year, due to failure of concrete. Of the balance in track, 15 are cracked through, 13 are spalled and crushed under rail and 20 have ends broken off at reinforcing steel.

Conowingo, C. & P. D.—39 ties removed during the year, due to failure of concrete. 22 ties in track are cracked through, two are spalled and crushed under rail and 15 have ends broken off at reinforcing steel.

Octoraro, C. & P. D.—55 ties removed during the year, due to failure of concrete, 25 ties in track are cracked through, 7 ties are spalled and crushed under rail, and 23 have ends broken off at reinforcing steel.

Silver Steel and Concrete, West Morrisville, Pa.—No change during year.

Willis Concrete, Manhattan Produce Yard—Ties are in fair condition.

Southern Pacific Lines

Reported by E. A. Craft, Engineer Maintenance of Way.
Date—September 30, 1930.
Kind—U. S. Indestructible.

A recent inspection of the concrete ties installed near Eagle Pass, Texas, in May, 1916, showed that they were still in good condition.

St. Louis and San Francisco

Reported by F. G. Jonah, Chief Engineer.
Date—September 3, 1930.
Kind—Clarke-Applegate.

The metal is getting very badly corroded, but the ties are still in service.

Terminal Railroad Association of St. Louis

Reported by H. J. Pfeifer, Chief Engineer.
Date—June 9, 1930.
Kind—Miller.

These ties are reported to be in the same condition as last year.

SUMMARY OF TESTS OF SUBSTITUTE TIES, NOW IN PROGRESS, 1930

Railroad	Name of tie	Location	Date Put in	Number Put in	Number Now in	Ballast	Rail Section, Pounds	Traffic
Atlanta & West Point	Duke	Louise, Ga.	1927	10	10	Stone and gravel	90	A
Bangor & Aroostook	Maine	Hudson, Me.	1923–4	69	69	Gravel	85	A
Bessemer & Lake Erie	Brown	Oakmont, Pa.	1930	1,500	1,500	Slag	130	C
Delaware & Hudson	Dalton Steel Tie	Various	1927–30	23,484	23,484	Cinder	90	E
Duluth & Iron Range	Carnegie	Various	1905	2,000	937	Gravel	80	C
	Hatch	Two Harbors, Minn.	1923	11	7	Gravel	80	C
Duluth, Missabe & Northern	Carnegie	Various	1908–9	22,380	19,397	Crushed Rock	100	A
	Kimball	Virginia, Minn.	1914	30	30	Gravel	100	C
Elgin, Joliet & Eastern	Bates	Whiting, Ind.	1912	62	60	Crushed Rock	85	C
	Carnegie	Various	1909–18	15,514	4,009	Gravel, Cinders, Slag	85–100	C
	Carnegie Switch	Various	1912–27	525,842*	44,564*	Gravel, Cinders, Slag	85–100	E
Long Island Railroad	Carnegie	Hicksville, N. Y.	1909	30	None	Cinder (All removed due to failure)	100	A
	King Concrete	Jamaica Stn., L. I.	1924	33	None	Stone		
Los Angeles Railway	McDonald Concrete	Los Angeles, Cal.	1911	4,323	736	Solid Concrete	87	B
Pennsylvania Railroad	Riegler Concrete	Ensworth, Pa.	1908	15	14	Stone	130	A
	Snyder Composite	Pittsburgh Div. Yards	1907	2,255	1,157	Cinder	100	F
		Aspinwall, Pa.	1925	100	98	Cinder	130	C
		Hayes, Pa.	1925	410	400	Stone	130	C
		Monongahela, Pa.	1927	2,516	2,516	Cinder	130	A
		Wilkinsburg, Pa.	1928	1,861	1,860	Stone	130	E
		Pitcairn, Pa.	1928	3,336	3,336	Cinder	130	C
		Derry, Pa.	1927	1,978	1,978	Cinder	130	E
	Brown Concrete	Conpitt Jct., Pa.	1927	2,843	2,843	Stone	130	C
		Tunnelton, Pa.	1928	2,385	2,385	Cinder	130	A
		Bellwood, Pa.	1927	3,006	2,735	Stone	130	C
		Highspire, Pa.	1927	1,486	1,424	Cinder	130	C
		M. P. 31—A. & S. Branch	1927	517	439	Cinder	130	C
		Haines, Pa. C. & P. D.	1927	970	917	Stone	130	A
		Conowingo, C. & P. D.	1927	1,986	1,947	Stone	130	A
		Octoraro, Pa. C. & P. D.	1927	1,993	1,938	Stone	130	A
	Silver Steel & Concrete	West Morrisville, Pa.	1923	102	4	Cinder	130	C
	Willis Concrete Tie	Manhattan Produce Yard	1927	24	24	Cinder	100	F
Southern Pacific Lines	U. S. Indestructible	Eagle Pass, Texas	1916	23	23	Cinder	80	D
St. Louis & San Francisco	Clark-Applegate	Springfield, Mo.	1914	125	125	Chats	85	C
Terminal R. R. Assn. of St. Louis	Miller	St. Louis, Mo.	1924	100	100	Cinder	100	A

*Lineal feet.
A—High speed, heavy service, passenger and freight.
B—High speed, exclusively passenger.
B.1—Slow speed, exclusively passenger.
C—Heavy service, exclusively freight.
D—Main Track, light service.
E—Yard track with heavy switching.
F—Yard track with light switching or storage usage.

Appendix D

(5) TIE RENEWAL AVERAGES PER MILE MAINTAINED

J. H. Roach, Chairman, Sub-Committee; M. S. Blaiklock, W. C. Bolin, J. F. Burns, W. M. Jaekle, S. S. Roberts, L. L. Tallyn, H. M. Tremaine, J. W. Williams, W. W. Wysor, R. C. Young.

Tables A and B, herewith, give the 1929 tie renewals as reported to the Interstate Commerce Commission, or in the case of the two principal Canadian railroads, as reported to the Committee in the same form.

The tables for the first time this year include the density of traffic figures. The unit of traffic is that approved by the Association. "Equated Gross Ton Miles" is the sum of gross ton-miles of freight cars, ton miles of passenger cars, twice the ton-miles of freight locomotives and three times the ton-miles of passenger locomotives.

Table A

CROSS TIES LAID IN REPLACEMENT ON LEADING RAILROADS IN THE UNITED STATES

CALENDAR YEAR ENDED DECEMBER 31, 1929

Road	Wooden ties untreated (U) Number	Wooden ties untreated (U) Average cost	Wooden ties treated (T) Number	Wooden ties treated (T) Average cost	Ties other than wood (S) and second hand	Total ties applied	Miles of maintained tracks occupied by cross ties (item 24)	Estimated total cross ties in all maintained tracks (item 25)	Equated gross ton-miles+
1	2	3	4	5	6	7	8	9	10
New England Region:									
#Atlantic & St. Lawrence	18,290	$.92	39,012	$1.95	--------	57,302	243.88	774,424	723,415,784
Bangor & Aroostook	214,075	.83	--------	------	--------	214,075	840.11	2,423,133	1,644,405,232
Boston & Maine	226,086	1.06	757,634	1.82	--------	983,720	3,789 39	10,775,000	17,906,982,552
†Canadian Pacific Lines in Maine	215	.69	66,140	1.27	--------	66,355	213 56	617,150	1,368,698,024
†Canadian Pacific Lines in Vermont	2,741	.59	36,973	1 23	--------	39,714	121.82	373,560	746,865,824
Central Vermont	9,310	1.10	133,921	1.87	--------	143,231	574.93	1,840,000	2,681,135,496
Maine Central	280,202	1.10	--------	------	--------	280,202	1,373 62	4,166,500	4,658,029,152
New York Connecting	--------	------	6,188	2 05	--------	6,188	26 03	83,300	409,227,616
New York, New Haven & Hartford	16,967	1.29	1,190,439	1.88	--------	1,207,406	4,521.88	14,109,872	25,151,115,560
Rutland	133	1.00	147,563	1.70	--------	147,696	547 49	1,582,335	2,196,835,184
Great Lakes Region:									
Ann Arbor	--------	------	84,201	1.68	--------	84,201	416 99	1,250,970	1,987,534,280
Buffalo, Rochester & Pittsburgh	24 531	1.10	78,290	2 46	--------	102,821	969 82	2,700,950	6,225,443,808
Delaware & Hudson	23,668	1.66	282,620	2.65	12,725	319,013	1,520 95	4,584,078	12,005,064,448
Delaware, Lackawanna & Western	1,374	.97	209,352	1 90	--------	210,726	2,507 56	7,271,924	22,320,787,021
#Detroit & Mackinac	207	.60	56,375	.99	*28,752	85,334	345 22	1,035,672	306,122,816
Detroit & Toledo Shore Line	--------	------	19,997	2 04	--------	19,997	151.59	479,313	831,111,000
Erie	20,879	99	901,382	2 16	--------	922,261	4,380 16	11,213,210	46,269,448,664
Chicago & Erie	1,748	1.07	195,354	2 39	--------	197,102	692 84	1,983,182	
#Grand Trunk System	353,749	1.11	228,245	1.65	--------	581,994	1,922 29	6,217,438	10,539,766,704
Lehigh & Hudson River	436	1.15	6,114	1.67	--------	6,550	133 60	348,300	875,910,400
Lehigh & New England	3,338	1.15	37,113	2.02	100	40,551	305 65	907,867	1,013,646,000
Lehigh Valley	--------	------	232,638	1.99	--------	232,638	3,137.47	9,262,016	20,528,210,632
Michigan Central	17,388	1.00	342,730	2.25	*17,825	377,943	3,540 78	11,086,182	27,722,202,968
Monongahela	46,923	1.69	1,923	2.29	--------	48,846	242 22	711,760	1,419,161,712
Montour	5,624	1.84	17,945	2.24	--------	23,569	76 95	217,760	343,185,000
New Jersey & New York	--------	------	7,076	2.08	--------	7,076	57.05	146,045	348,732,544
New York Central	71,116	1.01	2,031,700	1.97	--------	2,102,816	14,802 14	46,883,725	127,676,210,928
New York Chicago & St. Louis	3,078	.99	443,040	1.96	103	446,221	2,634.38	8,511,695	20,310,977,240
New York Ontario & Western	1,582	1.14	120,679	1.83	--------	122,261	915.13	2,607,977	4,179,492,144
New York, Susquehanna & Western	1,956	1.66	45,966	1 99	--------	47,922	234 18	599,500	733,243,896
Pere Marquette	13,035	.82	610,633	1 43	--------	623,668	2,932.78	8,800,122	13,115,208,896
Pittsburgh & Lake Erie	2,515	.69	67,654	2.32	--------	70,169	957 68	2,862,247	6,505,870,712

Table A

CROSS TIES LAID IN REPLACEMENT ON LEADING RAILROADS IN THE UNITED STATES

CALENDAR YEAR ENDED DECEMBER 31, 1929

Road	Wooden ties untreated (U)		Wooden ties treated (T)		Ties other than wood (S) and second hand	Total ties applied	Miles of maintained tracks occupied by cross ties (item 24)	Estimated total cross ties in all maintained tracks (item 25)	Equated gross ton-miles+
	Number	Average cost	Number	Average cost					
1	2	3	4	5	6	7	8	9	10
Great Lakes Region:—Continued									
Pittsburg & Shawmut	41,531	1.12	--------	------	**115	41,646	129 01	359,305	339,788,264
Pittsburgh & West Virginia	28,008	1.63	--------	------	--------	28,008	153.55	445,803	587,772,784
Pittsburg, Shawmut & Northern	29,854	1.20	29,363	2.12	--------	59,217	243.64	679,766	503,113,808
Ulster & Delaware	2,865	.88	6,135	1.67	--------	9,000	158.12	432,100	262,599,416
Wabash	16,499	.99	727,397	1.58	--------	743,896	3,364.00	10,587,995	27,488,670,976
Central Eastern Region:									
Akron, Canton & Youngstown	78,155	1.60	--------	------	--------	78,155	215.27	619,977	581,462,536
Atlantic City	--------	------	32,047	2.04	--------	32,047	309.05	890,121	986,074,912
Baltimore & Ohio	28,677	.70	1,629,570	1.70	6	1,658,253	10,673.62	27,819,605	78,413,846,696
Bessemer & Lake Erie	59,218	1.88	58,917	2.27	1,013	119,148	519.59	1,639,719	4,834,788,888
Buffalo & Susquehanna	66,919	1.36	--------	------	--------	66,919	299.31	843,845	458,996,304
Central R. R. of New Jersey	--------	------	121,396	2.07	--------	121,396	1,529.24	4,304,884	11,298,649,968
Chicago & Eastern Illinois	81	1.15	201,744	1.53	--------	201,825	1,691.08	5,072,397	8,923,293,640
Chicago & Illinois Midland	1,027	.88	34,598	1.56	--------	35,625	160.00	454,410	673,128,232
Chicago, Indianapolis & Louisville	4,549	.91	112,733	1.38	*1,214	118,496	891.65	2,744,238	5,678,371,904
Cincinnati Northern	552	1.44	35,420	2 19	--------	35,972	273.00	814,327	1,291,537,688
Cleveland, Cincinnati, Chicago & St. Louis	227	.56	423,202	1.89	--------	423,429	4,121.75	12,696,688	33,129,858,152
Detroit, Toledo & Ironton	753	.74	109,647	1 99	--------	110,400	675.21	1,944,605	2,464,780,256
Elgin, Joliet & Eastern	146	1.27	236,572	1 43	{*1,788 10}	238,516	881.00	2,727,558	4,480,426,000
Evansville, Indianapolis & Terre Haute	651	.84	44,261	1 24	--------	44,912	174.00	544,492	639,126,344
Hocking Valley	41,776	.89	205,688	1.79	--------	247,464	862.38	2,587,140	6,701,157,224
Illinois Terminal	2,732	.90	43,656	1.52	{*5,345 23}	51,756	606.34	°1,599,840	743,520,000
Long Island	10,865	1.34	156,148	2 07	26	167,039	866.69	2,432,206	2,260,780,024
Missouri Illinois	61,890	.71	1,349	1.18	--------	63,239	243.69	701,700	384,197,696
Pennsylvania	150,384	1.37	3,437,369	1 99	--------	3,587,753	22,259.40	62,600,234}	207,977,006,376
West Jersey & Seashore	130	.42	48,911	2.26	--------	49,041	560.73	1,508,560}	
Reading Company	188	1.09	482,184	1.95	--------	482,372	3,269.00	9,274,522	21,880,369,056
Staten Island Rapid Transit	--------	------	7,879	1 86	--------	7,879	103.13	283,155	--------------
Western Maryland	138,983	1.22	166,150	1.77	--------	305,133	1,193.51	3,437,312	5,966,966,064
Wheeling & Lake Erie	84,738	1 29	151,593	1.88	--------	236,331	885.24	2,666,779	4,552,836,040

Table A

CROSS TIES LAID IN REPLACEMENT ON LEADING RAILROADS IN THE UNITED STATES

CALENDAR YEAR ENDED DECEMBER 31, 1929

Road	Wooden ties untreated (U)		Wooden ties treated (T)		Ties other than wood (S) and second hand	Total ties applied	Miles of maintained tracks occupied by cross ties (item 24)	Estimated total cross ties in all maintained tracks (item 25)	Equated gross ton-miles+
	Number	Average cost	Number	Average cost					
1	2	3	4	5	6	7	8	9	10
Pocahontas Region:									
Chesapeake & Ohio	9,072	.81	832,555	1.26	--------	841,627	4,298.28	12,761,277	49,879,881,760
Norfolk & Western	42,281	.67	833,338	1.57	--------	875,619	4,308.98	13,357,838	44,820,180,712
Richmond, Fredericksburg & Potomac	160,795	1.11	--------	------	*2,183	162,978	379.43	1,086,700	4,033,728,112
Virginian	173,843	.80	116,502	1.51	*1,283	291,628	816.97	2,572,996	6,800,502,440
Southern Region:									
Alabama Great Southern	50,815	.97	176,140	1.34	--------	226,955	554.90	1,711,579	3,394,288,736
Atlanta & West Point	4,275	1.32	26,998	1.34	--------	31,273	[b]164.94	[c]435,600	1,575,841,360
Western Ry. of Alabama	1,611	1.15	41,193	1.32	--------	42,804	185.06	554,557	
Atlanta, Birmingham & Coast	141,382	.92	97,779	1.29	--------	239,161	789.46	2,297,968	1,756,719,280
Atlantic Coast Line	695,299	1.05	917,957	1.17	--------	1,613,256	6,892.25	19,955,131	25,594,508,488
Central of Georgia	14,608	.73	509,676	.94	100	524,384	2,569.56	7,153,000	9,132,342,584
Charleston & Western Carolina	132,825	1.20	--------	------	--------	132,825	427.78	1,240,591	953,157,616
Cincinnati, New Orleans & Tex. Pac.	64,440	.97	219,190	1.67	--------	283,630	720.06	2,223,374	8,429,306,368
Clinchfield	138,306	.82	52,747	1.43	--------	191,053	401.35	1,222,418	2,295,696,096
Columbus & Greenville	27,634	.95	63,843	1.37	--------	91,477	204.85	648,965	384,301,520
Florida East Coast	22,090	.99	72,618	1.92	--------	94,708	1,529.89	4,392,336	4,799,650,842
Georgia	30,362	1.32	95,110	1.40	--------	125,472	439.46	1,300,455	1,730,530,394
Georgia & Florida	89,252	.75	--------	------	--------	89,252	489.77	1,306,217	468,436,824
Georgia Southern & Florida	151,933	1.02	24,573	1.43	--------	176,506	480.75	1,506,723	1,795,886,472
Gulf & Ship Island	12,013	1.39	111,686	1.22	--------	123,699	344.84	1,078,670	850,772,920
Gulf, Mobile & Northern	38,430	.70	114,376	1.13	--------	152,806	726.36	2,189,440	2,296,882,632
Illinois Central	56,412	1.26	1,452,507	1.13	--------	1,508,919	8,034.20	24,585,702	67,798,119,344
Yazoo & Mississippi Valley	64,372	1.23	609,605	1.21	--------	673,977	2,264.30	6,923,156	
Louisville & Nashville	245,498	.99	1,575,817	1.70	--------	1,821,315	7,509.74	21,064,121	
Louisville, Henderson & St. Louis (To 7-1-29)	--------	------	22,992	------	--------	22,992	228.65	673,248	48,063,198,664
Mississippi Central	2,984	.78	30,858	1.17	--------	33,842	172.16	541,434	336,325,592
Mobile & Ohio	438,108	.90	34,068	1.22	--------	472,086	1,283.96	4,067,597	6,178,886,208
Nashville, Chattanooga & St. Louis	26,705	.58	372,213	1.38	--------	398,918	1,598.84	4,729,360	7,719,420,960
New Orleans & Northeastern	24,060	1.03	73,682	1.39	--------	97,742	289.65	893,678	1,915,015,648
New Orleans Great Northern	5,769	.57	77,288	1.18	--------	83,057	277.21	902,065	681,440,672
Norfolk Southern	309,941	.85	--------	------	--------	309,941	1,096.43	3,067,204	2,076,169,184
Northern Alabama	62,897	.95	--------	------	--------	62,897	144.02	455,066	314,158,040

Table A

CROSS TIES LAID IN REPLACEMENT ON LEADING RAILROADS IN THE UNITED STATES

Calendar Year Ended December 31, 1929

Road	Wooden ties untreated (U)		Wooden ties treated (T)		Ties other than wood (S) and second hand	Total ties applied	Miles of maintained tracks occupied by cross ties (item 24)	Estimated total cross ties in all maintained tracks (item 25)	Equated gross ton-miles+
	Number	Average cost	Number	Average cost					
1	2	3	4	5	6	7	8	9	10
Southern Region:—Continued									
Seaboard Air Line	1,304,810	1.01	125,910	1.02	--------	1,430,720	5,698.95	17,720,600	20,365,698,240
Southern Ry.	2,387,041	.97	1,143,558	1.42	--------	3,530,599	9,004.43	28,475,905	45,968,805,104
Tennessee Central	107,930	.74	46,531	1.77	--------	154,461	355 22	1,100,110	870,416,216
Northwestern Region:									
Chicago & Northwestern	74,150	.67	2,249,231	1 21	--------	2,323,381	12,688.64	36,459,106	51,094,582,712
Chicago Great Western	77,388	.94	324,340	1 10	--------	401,728	1,962.92	5,648,980	10,195,579,152
Chicago, Milwaukee, St. Paul & Pacific	678,658	.66	3,630,963	1.15	--------	4,309,621	15,028.32	43,615,754	60,538,430,488
Chicago, St. Paul, Minneapolis & Omaha	204,581	.65	465,819	1 45	19	670,419	2,374.56	7,036,838	9,288,726,408
Duluth & Iron Range	44,828	.77	83,848	1.93	--------	128,176	475.40	1,488,477	1,335,303,152
Duluth, Missabe & Northern	24,031	.85	115,452	2.14	--------	139,483	715.84	2,188,191	3,378,623,648
Duluth, South Shore & Atlantic	188,722	.76	--------	------	--------	188,722	694.93	2,078,222	1,319,772,448
#Duluth, Winnipeg & Pacific	83,848	.73	--------	------	--------	83,848	217.16	651,483	823,609,928
Great Northern	71,177	.60	2,005,863	1.27	*68,491	2,145,531	10,126.57	32,402,278	38,568,480,736
Green Bay & Western	93,028	.89	--------	------	--------	93,028	288.97	809,116	510,307,720
Lake Superior & Ishpeming	57,610	71	--------	------	--------	57,610	230.31	690,930	283,037,424
Minneapolis & St. Louis	149,979	1.00	121,562	1 34	--------	271,541	1,812.30	5,459,555	4,927,489,280
Minneapolis, St. Paul & Sault Ste. Marie	642,358	.77	612,428	1.43	--------	1,254,786	5,270 75	15,506,097	15,211,819,960
Northern Pacific	127,410	.62	1,403,655	1 28	42	1,531,107	9,062.23	26,314,618	31,236,769,712
Oregon-Washington R.R. & Nav. Co.	4,735	.46	444,589	.87	--------	449,324	2,266.79	6,522,905	8,076,397,248
Spokane International	68,979	.55	--------	------	--------	68,979	193.96	547,589	272,211,904
Spokane, Portland & Seattle	21,709	.57	213,542	1.25	--------	235,251	661.70	1,904,922	2,725,257,624
Central Western Region:									
Atchison, Topeka & Santa Fe	15,726	.96	2,524,802	1.44	--------	2,540,528	14,437.40	43,846,384	
Panhandle & Santa Fe	--------	------	293,965	1.53	--------	293,965	2,014.48	6,029,671	83,998,728,920
Bingham & Garfield	6,419	2.09	10,309	2.35	*107 180	17,015	79.73	156,100	44,425,000
Chicago & Alton	341,946	1.16	15,799	1.06	*8,096	365,841	1,642.91	4,918,620	10,031,770,176
Chicago, Burlington & Quincy	--------	------	2,175,920	1.29	*82,765 n4,339	2,213,024	12,941.94	39,964,710	57,150,719,312

Table A

CROSS TIES LAID IN REPLACEMENT ON LEADING RAILROADS IN THE UNITED STATES

Calendar Year Ended December 31, 1929

Road	Wooden ties untreated (U) Number	Wooden ties untreated (U) Average cost	Wooden ties treated (T) Number	Wooden ties treated (T) Average cost	Ties other than wood (S) and second hand	Total ties applied	Miles of maintained tracks occupied by cross ties (item 24)	Estimated total cross ties in all maintained tracks (item 25)	Equated gross ton-miles+
1	2	3	4	5	6	7	8	9	10
Central Western Region:—Continued									
Chicago, Rock Island & Pacific	a1,988	.60	a1,529,138	1.11	2,750	1,533,876	9,797.51	29,427,512	
Chicago, Rock Island & Gulf	--------	------	127,422	1.38	*558	127,980	690.83	1,934,281	60,853,070,288
Colorado & Southern	55,265	.44	137,383	1.45	*4,757	197,405	1,233.31	3,732,156	3,723,799,296
Denver & Rio Grande Western	22,817	.99	666,494	1.18	n236,550	925,861	3,479.70	10,824,115	10,846,575,584
Denver & Salt Lake	51,288	1.28	15	2.29	--------	51,303	325.48	976,440	745,101,000
Fort Worth & Denver City	--------	------	180,221	1.34	--------	180,221	849.69	2,569,359	3,841,201,520
Los Angeles & Salt Lake	904	1.25	245,652	1.51	--------	246,556	1,480.36	4,106,889	9,139,646,728
Nevada Northern	35,042	.98	--------	------	--------	35,042	191.12	548,293	174,121,984
Northwestern Pacific	171,171	.77	--------	------	--------	171,171	581.63	1,719,989	1,114,842,024
Oregon Short Line	--------	------	597,190	1.22	--------	597,190	3,364.87	9,347,963	12,734,812,810
Quincy, Omaha & Kansas City	--------	------	49,741	1.46	--------	49,741	263.76	828,206	185,783,024
St. Joseph & Grand Island	60,479	1.27	--------	------	--------	60,479	331.07	983,219	1,247,957,261
San Diego & Arizona	19,708	1.09	2	2.53	--------	19,710	172.37	508,452	215,839,960
Southern Pacific Co.—Pacific Lines	395,209	.93	2,207,841	1.36	--------	2,603,050	12,895.50	37,615,173	72,735,863,784
Toledo, Peoria & Western	49,023	1.13	19,239	1.57	--------	68,262	276.34	875,445	599,981,176
Union Pacific	--------	------	966,112	1.27	--------	966,112	5,949.00	16,780,500	50,130,293,752
Utah Ry.	7,768	.61	9,577	1.92	--------	17,345	86.24	221,224	476,071,000
Western Pacific	568,015	.79	30	1.68	--------	568,045	1,333.54	3,816,132	7,115,398,072
Southwestern Region:									
Fort Smith & Western	80,360	.66	--------	------	--------	80,360	234.82	734,500	470,201,896
Fort Worth & Rio Grande	45,594	.96	59,018	1.56	--------	101,612	245.36	777,302	382,812,112
Gulf Coast Lines:									
Beaumont, Sour Lake & Western	--------	------	30,900	1.26	--------	30,900	140.98	420,200	
New Orleans, Texas & Mexico	--------	------	54,164	1.26	--------	54,164	225.54	690,100	4,991,701,688
St. Louis, Brownsville & Mexico	--------	------	133,405	1.16	*64	133,469	725.98	2,201,700	
Gulf, Colorado & Santa Fe	2,435	.56	508,184	1.27	--------	510,619	2,490.72	8,064,951	10,058,016,864
International—Great Northern	777	.82	313,878	1.25	--------	314,655	1,472.04	4,421,500	6,202,459,576
Kansas City Southern	2,572	.65	181,036	1.33	*5	183,613	1,166.78	3,657,784	
Texarkana & Fort Smith	--------	------	18,782	1.67	--------	18,782	160.78	501,426	6,839,136,624
Kansas, Oklahoma & Gulf	338	1.17	41,517	1.48	--------	41,855	373.59	1,207,081	994,328,848
Louisiana & Arkansas	87,914	.90	149,692	1.17	--------	237,606	785.25	2,512,800	1,874,522,336
Louisiana Ry. & Navigation Co. of Texas	68,536	.91	2,585	1.25	--------	71,121	215.75	690,661	338,138,656

Table A

CROSS TIES LAID IN REPLACEMENT ON LEADING RAILROADS IN THE UNITED STATES

CALENDAR YEAR ENDED DECEMBER 31, 1929

Road	Wooden ties untreated (U) Number	Wooden ties untreated (U) Average cost	Wooden ties treated (T) Number	Wooden ties treated (T) Average cost	Ties other than wood (S) and second hand	Total ties applied	Miles of maintained tracks occupied by cross ties (item 24)	Estimated total cross ties in all maintained tracks (item 25)	Equated gross ton-miles+
1	2	3	4	5	6	7	8	9	10
Southwestren Region:—Continued									
Midland Valley	5,128	.88	83,675	1.51	--------	88,803	426.76	1,370,400	779,098,968
Missouri & North Arkansas	110,521	.75	--------	------	--------	110,521	338.57	1,003,184	583,767,736
Missouri-Kansas-Texas Lines									
Missouri-Kansas-Texas	151	.88	466,546	1.31	--------	466,697	2,318 66	7,294,800	
Missouri-Kansas-Texas of Texas	--------	------	398,803	1.31	--------	398,803	1.701.32	5,410,600	19,600,458,928
Missouri Pacific	704,086	.80	2,034,598	1.10	--------	2,738,684	9,305 29	28,878,000	49,984,437,464
St. Louis–San Francisco	443,373	.76	977,610	1.29	--------	1,420,983	6,966 73	21,647,212	27,374,549,976
St. Louis, San Francisco & Texas	13,276	.88	35,858	1.49	--------	49,134	147.05	465,854	438,359,424
St. Louis Southwestern	--------	------	326,323	1.37	*4,708	331,031	983 30	3,115,147	5,655,454,208
St. Louis Southwestern of Texas	--------	------	334,245	1.43	*24,166	358,411	961.23	3,004,174	2,523,332,336
San Antonio, Uvalde & Gulf	--------	------	87,039	1.26	*428	87,467	361.74	1,022,100	622,597,408
Texas & New Orleans	232,481	1.13	1,102,819	1.34	--------	1,335,300	6,021 70	16,652,805	23,543,079,392
Texas & Pacific	1,385	.83	752,054	1.20	--------	753,439	2,535.10	8,080,686	16,837,515,484
Texas Mexican	859	.66	60,315	1.58	--------	61,174	202 70	583,782	268,750,480
Trinity & Brazos Valley	99	.50	87,273	.99	--------	87,372	354.46	1,110,523	691,345,896
Wichita Falls & Southern	--------	------	42,853	1.27	--------	42,853	198.99	656,667	173,237,928
Wichita Valley	--------	------	59,548	1.22	--------	59,548	297.10	890,621	323,343,872

* All second hand.
** Kind of tie undetermined.
‡ Maischaider formula.
[a] Includes second hand ties, not separated.
[b] All tracks operated less trackage rights.
[c] Estimated by Bureau of Railway Economics on basis of 2,640 ties to the mile.
n Indicates narrow gauge ties.
NOTE: Compiled from Annual Reports of Class I Steam Roads to the Interstate Commerce Commission.

\#Included in Summary figures for Canadian National Rys.
†Included in Summary figures for Canadian Pacific Ry.

CANADIAN ROADS

Road	Untreated Number	Untreated Average cost	Treated Number	Treated Average cost	Ties other than wood and second hand	Total ties applied	Miles of maintained tracks	Estimated total cross ties	Equated gross ton-miles
Canadian Pacific Ry.—All Lines	2,085,220	$.66	2,950,718	$1.40	--------	5,035,938	20,893.00	58,704,930	------------
Canadian National Rys. (including Grand Trunk Lines in New England, Grand Trunk Western Ry., and Duluth, Winnipeg and Pacific Ry.)	6,115,811	.78	1,915,264	1.70	--------	8,031,075	30,857.50	87,247,730	-------------

Table B

WOODEN CROSS TIES LAID IN REPLACEMENT (TREATED AND UNTREATED) ON LEADING RAILROADS IN THE UNITED STATES

CALENDAR YEAR ENDED DECEMBER 31, 1929

Note: All figures are exclusive of Bridge and Switch Ties

Road	*Miles of maintained track occupied by cross-ties (Col. 8—table A)*	*Average number of cross-ties per mile of maintained track*	*Total number of wooden cross ties renewed 1929*	*Average number of wooden cross ties renewed per mile of maintained track*	*Weighted average cost per wooden cross tie*	*Average cost of wooden cross tie renewals per mile of maintained track*	*Average percentage of wooden cross tie renewals*	*Equated gross ton-miles per mile of maintained track*	*Cost of wooden cross tie renewals per thousand equated gross ton-miles*
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
New England Region:									
#Atlantic & St. Lawrence	243.88	3,175	57,302	235	$1.63	$383	7.4	2,966,278	$.13
Bangor & Aroostook	840.11	2,884	214,075	255	.83	212	8.8	1,957,369	.11
Boston & Maine	3,789.39	2,843	983,720	260	1.64	426	9.1	4,725,558	.09
†Canadian Pacific Lines in Maine	213.56	2,890	66,355	311	1.27	395	10.8	6,408,963	.06
†Canadian Pacific Lines in Vermont	121.82	3,066	39,714	326	1.18	385	10.6	6,130,897	.06
Central Vermont	574.93	3,200	143,231	249	1.82	453	7.8	4,663,412	.10
Maine Central	1,373.62	3,083	280,202	204	1.10	224	6.7	3,391,061	.07
New York Connecting	26.03	3,200	6,188	238	2.05	488	7.4	15,721,384	.03
New York, New Haven & Hartford	4,521.88	3,120	1,207,406	267	1.82	486	8.6	5,562,093	.09
Rutland	547.49	2,890	147,696	270	1.70	459	9.3	4,012,558	.11
Great Lakes Region:									
Ann Arbor	416.99	3,000	84,201	202	1.68	339	6.7	4,766,384	.07
Buffalo, Rochester & Pittsburgh	969.82	2,785	102,821	106	2.13	226	3.8	6,419,174	.04
Delaware & Hudson	1,520.95	3,014	306,288	201	2.58	519	6.7	7,893,135	.07
Delaware, Lackawanna & Western	2,507.56	2,900	210,726	84	1.89	159	2.9	8,901,397	.02
†Detroit & Mackinac	346.22	3,000	56,582	164	.99	162	5.5	1,060,537	.15
Detroit, Toledo Shore Line	151.59	3,162	19,997	132	2.04	269	4.2	5,482,624	.05
Erie	4,380.16	2,560	922,261	211	2.13	449	8.2	9,120,727	.05
Chicago & Erie	692.84	2,862	197,102	284	2.38	676	9.9		
#Grand Trunk System	1,922.29	3,234	581,994	303	1.32	400	9.4	5,482,922	.07
Lehigh & Hudson River	133.60	2,607	6,550	49	1.64	80	1.9	6,556,216	.01
Lehigh & New England	305.65	2,970	40,451	132	1.95	257	4.5	3,316,362	.08
Lehigh Valley	3,137.47	2,952	232,638	74	1.99	147	2.5	6,542,919	.02
Michigan Central	3,540.78	3,131	360,11	102	2.19	223	3.2	7,829,406	.03
Monongahela	242.22	2,938	48,846	202	1.72	347	6.9	5,982,833	.06
Montour	76.95	2,830	23,569	306	2.14	655	10.8	4,459,844	.15
New Jersey & New York	57.05	2,560	7,076	124	2.08	258	4.8	6,112,753	.04
New York Central	14,802.14	3,167	2,102,816	142	1.90	270.	4.5	8,625,524	.03

Table B

WOODEN CROSS TIES LAID IN REPLACEMENT (TREATED AND UNTREATED) ON LEADING RAILROADS IN THE UNITED STATES

CALENDAR YEAR ENDED DECEMBER 31, 1929

Note: All figures are exclusive of Bridge and Switch Ties

Road 1	Miles of maintained track occupied by cross-ties (Col. 8—table A) 2	Average number of cross-ties per mile of maintained track 3	Total number of wooden cross ties renewed 1929 4	Average number of wooden cross ties renewed per mile of maintained track 5	Weighted average cost per wooden cross tie 6	Average cost of wooden cross tie renewals per mile of maintained track 7	Average percentage of wooden cross tie renewals 8	Equated gross ton-miles per mile of maintained track 9	Cost of wooden cross tie renewals per thousand equated gross ton-miles 10
Great Lakes Region:—Continued									
New York, Chicago & St. Louis	2,634 38	3,231	446,118	169	1.95	330	5 2	7,709,965	.04
New York, Ontario & Western	915.13	2,850	122,261	134	1.82	244	4.7	4,567,102	.05
New York, Susquehanna & Western	234.18	2,560	47,922	275	1 90	404	8 0	3,131,112	13
Pere Marquette	2,932.78	3,001	623,668	213	1.42	302	7 1	4,471,938	07
Pittsburgh & Lake Erie	957.68	2,989	70,169	73	2.26	165	2 5	6,793,373	02
Pittsburg & Shawmut	129 01	2,785	41,531	322	1.12	361	11 6	2,633,813	.14
Pittsburgh & West Virginian	153.55	2,903	28,008	182	1 63	297	6 3	3,827,892	08
Pittsburg, Shawmut & Northern	243 64	2,790	59,217	243	1 65	401	8 7	2,064,989	19
Ulster & Delaware	158.12	2,733	9,000	57	1.42	81	2 1	1,660,760	.05
Wabash	3,364.00	3,147	743,896	221	1.57	347	7 0	8,171,424	04
Central Eastern Region:									
Akron, Canton & Youngstown	215.27	2,880	78,155	363	1 60	581	12.6	2,701,085	.22
Atlantic City	309 05	2,880	32,047	104	2.04	212	3 6	3,190,665	.07
Baltimore & Ohio	10,673 62	2,606	1,658,247	155	1.68	260	6 0	7,346,509	.04
Bessemer & Lake Erie	519.59	3,156	118,135	227	2 08	472	7 2	9,305,008	.05
Buffalo & Susquehanna	299.31	2,819	66,919	224	1.36	305	7.9	1,533,515	.20
Central R. R. of New Jersey	1,529.24	2,815	121,396	79	2 07	164	2 8	7,388,409	.02
Chicago & Eastern Illinois	1,691 08	3,000	201,825	119	1.52	181	4 0	5,276,683	.03
Chicago & Illinois Midland	160 00	2,840	35,625	223	1.54	343	7.8	4,207,051	.08
Chicago, Indianapolis & Louisville	891 65	3,078	117,282	132	1 36	180	4 3	6,368,387	.03
Cincinnati Northern	273.00	2,983	35,972	132	2.18	288	4.4	4,730,907	.06
Cleveland, Cincinnati, Chicago & St. Louis	4,121 75	3,080	423,429	103	1.89	195	3 3	8,037,814	.02
Detroit, Toledo & Ironton	675.21	2,880	110,400	164	1.98	325	5 7	3,650,391	.09
Elgin, Joliet & Eastern	881.00	3,096	236,718	269	1 43	385	8 7	5,085,614	.08
Evansville, Indianapolis & Terre Haute	174.00	3,129	44,912	258	1 23	317	8 2	3,673,140	.09
Hocking Valley	862.38	3,000	247,464	287	1.64	471	9.6	7,770,539	.06
Illinois Terminal	606.34	2,639	46,388	77	1.49	115	2.9	1,226,251	.09

Table B

WOODEN CROSS TIES LAID IN REPLACEMENT (TREATED AND UNTREATED) ON LEADING RAILROADS IN THE UNITED STATES

CALENDAR YEAR ENDED DECEMBER 31, 1929

Note: All figures are exclusive of Bridge and Switch Ties

Road 1	*Miles of maintained track occupied by cross-ties (Col 8—table A)* 2	*Average number of cross-ties per mile of maintained track* 3	*Total number of wooden cross ties renewed 1929* 4	*Average number of wooden cross ties renewed per mile of maintained track* 5	*Weighted average cost per wooden cross tie* 6	*Average cost of wooden cross tie renewals per mile of maintained track* 7	*Average percentage of wooden cross tie renewals* 8	*Equated gross ton-miles per mile of maintained track* 9	*Cost of wooden cross tie renewals per thousand equated gross ton-miles* 10
Central Eastern Region:—Continued									
Long Island	866.69	2,806	167,013	193	2 03	392	6 9	2,608,522	.15
Missouri-Illinois	248.69	2,879	63,239	260	72	187	9.0	1,576,584	.12
Pennsylvania	22,259.40	2,812	3,587,753	161	1.96	316	5 7		
West Jersey & Seashore	560.73	2,690	49,041	87	2.26	197	3 3	9,113,752	.03
Reading Company	3,269.00	2,837	482,372	148	1 95	289	5 2	6,693,291	.04
Staten Island Rapid Transit	103.13	2,746	7,879	76	1.87	142	2 8		
Western Maryland	1,193.51	2,880	305,133	256	1 52	389	8 9	4,999,507	.08
Wheeling & Lake Erie	885.24	3,012	236,331	267	1.67	446	8.9	5,113,053	.09
Pocahontas Region:									
Chesapeake & Ohio	4,298.28	2,969	841,627	196	1.55	245	6 6	11,604,614	.02
Norfolk & Western	4,308.98	3,100	875,619	203	1.53	311	6 6	10,401,575	.03
Richmond, Fredericksburg & Potomac	379 43	2,864	160,795	424	1 11	471	14.8	10,631,021	.04
Virginian	816.97	3,149	290,345	355	1.09	387	11.3	8,324,054	.05
Southern Region:									
Alabama Great Southern	554.90	3,084	226,955	409	1.26	515	13 3	6,116,938	.08
Atlanta & West Point	[b]164 94	2,641	31,273	190	1.34	255	7 2		
Western Ry. of Alabama	185.06	2,997	42,804	231	1 32	305	7.7	4,502,404	.06
Atlanta, Birmingham & Coast	789.46	2,911	239,161	303	1.07	324	10.4	2,225,216	.15
Atlantic Coast Line	6,892.25	2,895	1,613,256	234	1.12	262	8 1	3,713,520	.07
Central of Georgia	2,569.56	2,784	524,284	204	.93	190	7.3	3,554,049	.05
Charleston & Western Carolina	427 78	2,900	132,825	310	1 20	372	10 7	2,228,149	.17
Cincinnati, New Orleans & Tex. Pac.	720 06	3,088	283,630	394	1.51	595	12.8	11,706,394	.05
Clinchfield	401.35	3,046	191,053	476	.99	471	15.6	5,719,935	.08
Columbus & Greenville	204.85	3,168	91,477	447	1.24	554	14.1	1,876,014	.30
Florida East Coast	1,529.89	2,871	94,708	62	1.71	106	2.2	3,137,262	.03
Georgia	439.46	2,959	125,472	286	1.38	395	9.6	3,937,856	.10
Georgia & Florida	489.77	2,667	80,252	182	.75	137	6.8	956,442	.14

Table B

WOODEN CROSS TIES LAID IN REPLACEMENT (TREATED AND UNTREATED) ON LEADING RAILROADS IN THE UNITED STATES

CALENDAR YEAR ENDED DECEMBER 31, 1929

Note: All figures are exclusive of Bridge and Switch Ties

Road 1	*Miles of maintained track occupied by cross-ties (Col. 8—table A)* 2	*Average number of cross-ties per mile of maintained track* 3	*Total number of wooden cross ties renewed 1929* 4	*Average number of wooden cross ties renewed per mile of maintained track* 5	*Weighted average cost per wooden cross tie* 6	*Average cost of wooden cross tie renewals per mile of maintained track* 7	*Average percentage of wooden cross tie renewals* 8	*Equated gross ton-miles per mile of maintained track* 9	*Cost of wooden cross tie renewals per thousand equated gross ton-miles* 10
Southern Region:—Continued									
Georgia, Southern & Florida	480.75	3,134	176,506	367	1.08	396	11 7	3,937,593	.11
Gulf & Ship Island	344.84	3,128	123,699	359	1.24	445	11 5	2,467,153	.18
Gulf, Mobile & Northern	726.36	3,014	152,806	210	1.02	214	7 0	3,162,182	.07
Illinois Central	8,034.20	3,060	1,508,919	188	1.14	214	6.1	6,583,300	.04
Yazoo & Mississippi Valley	2,264 30	3,058	673,977	298	1.21	361	9.7		
Louisville & Nashville	7,509.74	2,805	1,821,315	243	1.60	389	8 6		
Louisville, Henderson & St. Louis (To 7-1-29)	228.65	2,944	22,992	101	--------	--------	3 4	6,211,008	.06
Mississippi Central	172.16	3,145	33,842	197	1.14	225	6.3	1,953,564	.11
Mobile & Ohio	1,283.96	3,168	472,086	368	.92	339	11 6	4,812,367	.07
Nashville, Chattanooga & St. Louis	1,598.84	2,958	398,918	250	1.33	333	8 4	4,828,139	07
New Orleans & Northeastern	289.65	3,085	97,742	337	1.30	438	10 9	6,611,482	.07
New Orleans Great Northern	277.21	3,254	83,057	300	1.14	342	9 2	2,458,211	.14
Norfolk Southern	1,096.43	2,797	309,941	283	.85	241	10.1	1,893,572	.13
Northern Alabama	144.02	3,160	62,897	437	.95	415	13.8	2,181,350	.19
Seaboard Air Line	5,698.95	3,109	1,430,720	251	1.01	254	8 1	3,573,588	.07
Southern Ry.	9,004.43	3,162	3,530,599	392	1.11	435	12.4	5,105,132	.09
Tennessee Central	355.22	3,097	154,461	435	1.05	457	14.0	2,450,372	.19
Northwestern Region:									
Chicago & Northwestern	12,688.64	2,873	2,323,381	183	1.19	218	6.4	4,026,797	.05
Chicago & Great Western	1,962.92	2,878	401,728	205	1.07	219	7.1	5,194,088	.04
Chicago, Milwaukee, St. Paul & Pac.	15,028.32	2,902	4,309,621	287	1.07	307	9.9	4,028,290	.08
Chicago, St. Paul, Minneapolis & Omaha	2,374.56	2,963	670,400	282	1.21	341	9.5	3,911,767	.09
Duluth & Iron Range	475.40	3,131	128,176	270	1.53	413	8.6	2,808,799	.15
Duluth, Missabe & Northern	715.84	3,057	139,483	195	1.92	374	6.4	4,719,803	.08
Duluth, South Shore & Atlantic	694.93	2,991	188,722	272	.76	207	9.1	1,899,144	.11
#Duluth, Winnipeg & Pacific	217.16	3,000	83,848	386	.73	282	12.9	3,792,641	.07

Table B

WOODEN CROSS TIES LAID IN REPLACEMENT (TREATED AND UNTREATED) ON LEADING RAILROADS IN THE UNITED STATES

CALENDAR YEAR ENDED DECEMBER 31, 1929

Note: All figures are exclusive of Bridge and Switch Ties

Road 1	Miles of maintained track occupied by cross-ties (Col. 8—table A) 2	Average number of cross-ties per mile of maintained track 3	Total number of wooden cross ties renewed 1929 4	Average number of wooden cross ties renewed per mile of maintained track 5	Weighted average cost per wooden cross tie 6	Average cost of wooden cross tie renewals per mile of maintained track 7	Average percentage of wooden cross tie renewals 8	Equated gross ton-miles per mile of maintained track 9	Cost of wooden cross tie renewals per thousand equated gross ton-miles 10
Northwestern Region:—Continued									
Great Northern	10,126.57	3,200	2,077,040	205	1.24	254	6.4	3,808,642	.07
Green Bay & Western	288.97	2,800	93,028	322	.89	287	11.5	1,765,954	.16
Lake Superior & Ishpeming	230.31	3,000	57,610	250	.71	178	8.3	1,228,941	.14
Minneapolis & St. Louis	1,812.30	3,013	271,541	150	1.15	173	5.0	2,718,915	.06
Minneapolis, St. Paul & Sault Ste. Marie	5,270.75	2,942	1,254,786	238	1.09	259	8.1	2,886,083	.09
Northern Pacific	9,062.23	2,904	1,531,065	169	1.23	208	5.8	3,446,919	.06
Oregon-Washington-R.R. & Nav. Co.	2,266.79	2,878	449,324	198	.87	172	6.9	3,562,923	.05
Spokane International	193.96	2,823	68,979	356	.55	196	12.6	1,403,444	.14
Spokane, Portland & Seattle	661.70	2,879	235,251	356	1.19	424	12.3	4,118,570	.10
Central Western Region:									
Atchison, Topeka & Santa Fe	14,437.40	3,037	2,540,528	176	1.44	253	5.8 }		
Panhandle & Santa Fe	2,014.48	2,993	293,965	146	1.53	223	4.9 }	5,105,722	.05
Bingham & Garfield	79.73	1,958	16,728	210	2.25	473	10.7	557,193	.85
Chicago & Alton	1,642.91	2,994	357,745	218	1.16	253	7.3	6,106,098	.04
Chicago, Burlington & Quincy	12,941.94	3,088	2,175,920	168	1.30	218	5.4	4,415,931	.05
Chicago, Rock Island & Pacific	9,797.51	3,004	1,531,126	156	1.11	173	5.2 }	4,848,534	.04
Chicago, Rock Island & Gulf	690.83	2,800	127,422	184	1.38	254	6.6 }		
Colorado & Southern	1,233.31	3,026	192,648	156	1.16	181	5.2	3,019,357	.06
Denver & Rio Grande Western	3,479.70	3,111	689,311	198	1.18	234	6.4	3,117,101	.07
Denver & Salt Lake	325.48	3,000	51,303	158	1.28	202	5.3	2,289,237	.09
Fort Worth & Denver City	849.69	3,024	180,221	212	1.34	284	7.0	4,524,240	.06
Los Angeles & Salt Lake	1,480.36	2,774	246,556	167	1.51	252	6.0	6,173,935	.04
Nevada Northern	191.12	2,869	35,042	183	.98	179	6.4	911,077	.20
Northwestern Pacific	581.63	2,957	171,171	294	.77	226	10.0	1,916,755	.12
Oregon Short Line	3,364.87	2,778	597,190	177	1.22	216	6.4	3,784,637	.06
Quincy, Omaha & Kansas City	263.76	3,140	49,741	189	1.46	276	6.0	704,364	.04
St. Joseph & Grand Island	331.07	2,970	60,479	183	1.27	232	6.2	3,769,466	.06

Appendix E

(6) METHODS AND PRACTICES FOR PROPER SEASONING OF TIES, WITH PARTICULAR REFERENCE TO INCREASING THE SERVICE LIFE.

H. R. Clarke, Chairman, Sub-Committee; John Foley, W. R. Ballord, R. S. Belcher, H. F. Brown, C. W. Greene, C. S. Kirkpatrick, F. C. Krell, H. C. Munson.

As such a large percentage of ties are now being treated this subject naturally divides itself:

First—Handling previous to receipt at treating plant.

Second—Seasoning at treating plant yards.

(A) Handling previous to receipt at treating plant.

(1) Ties should be moved promptly, after they are made, from the woods to the tie yard. They shall be moved within 30 days.
Ties shall be moved from tie yard to treating plant as promptly as possible. This movement naturally depends on the method of transit; stages of water and road conditions at times must govern.

(2) While waiting shipment ties shall be piled in cribs of 2 and 7 as described in paragraph 22 "Specification for Cross-Ties" of this Association.

(3) Ties should be stacked on ground bare of debris or vegetation for at least two feet around each stack and clear of vegetation over six inches high within ten feet of any stack and sufficiently well-drained so that water will not stand under the stacks or in their immediate vicinity. Decaying wood debris should be thoroughly removed.

(B) Seasoning at treating plant yards.

(1) Tie treating plant yards shall be well-drained to permit rapid run off of rainfall and be so graded that water does not stand in low spots.

(2) Tie treating yards shall be kept free from vegetation and decayed or rotting wood.

(3) Ties shall be piled in such a way as to permit free circulation of air; this to be accomplished with the minimum bearing of one tie on another.
The particular method of piling best adapted to any given seasoning yard depends upon such factors as species of wood, yard site, weather conditions and on whether the dominant defect is decay or checking.
The best spacing will depend somewhat on the average humidity of the location. No tie should touch the adjacent tie in the layer and a space of from 2 inches to 4 inches, depending on local conditions of humidity, should be left between the ties.
Tie piles shall be a sufficient distance apart to permit proper inspection so that seasoning may be watched and any evidence of decay readily detected.

(4) Treated sills or concrete blocks shall be used as foundation for ties piled for seasoning. The bottom ties in the pile shall be at least 6 inches above the ground.

(5) Ties shall be treated promptly after the timber has been seasoned to the proper point.

(6) After treating, ties should be allowed to season and dry at either the treating plant or on the line before being placed in track.
Zinc treated ties should be stacked so as to obtain free circulation of air with minimum contact.
Creosoted ties should be stacked as compactly as practicable.

Appendix F

(8) COMPARISON OF TIES RENEWED PER MAINTAINED MILE WITH PROPER ADJUSTMENT FOR RATE OF APPLICATION OF TREATED TIES SINCE THE BEGINNING OF THEIR USE AND FOR TRAFFIC, USING THE APPROVED TRAFFIC UNIT

W. C. Bolin, Chairman, Sub-Committee; R. L. Cook, P. B. Jeffries, M. F. Longwill, J. H. Roach, S. S. Roberts, S. E. Shoup, L. L. Tallyn, H. M. Tremaine, R. C. Young.

The Committee, while reporting progress, is not ready to report fully on this subject. However, as containing excellent and unique data bearing on this subject, the Committee presents, as part of this Appendix, the monograph by one of its members, Mr. S. E. Shoup, giving very complete data on the experience of the Kansas City Southern with creosoted ties.

STUDY OF THE LIFE OF UNTREATED HARDWOOD TIES AND CREOSOTED RED OAK TIES, BASED ON TIE RECORDS OF THE KANSAS CITY SOUTHERN RAILWAY

By S. E. Shoup

This study is based on the tie records of the Kansas City Southern Railway Company.

In the year 1908, the Kansas City Southern commenced the use of dating nails on each tie inserted and, at the same time, instituted a report of ties removed from track for the use of the section foremen. These records have been continuously maintained, with the consequence that the Kansas City Southern is one of the few railroads in America on which reliable tie data are available for the system as a whole.

The statistics on untreated hardwood ties are developed from the record of removal of 1,254,000 ties placed in 1908, 1909, 1910, 1915 and 1916.

The statistics on creosoted red oak ties are developed from the record of removal of 226,000 ties of a total of 2,616,000 placed commencing with 1910 and continuing in varying numbers each year thereafter.

Creosoted pine ties were used experimentally in 1909, 1910 and 1911, but their use was discontinued with the adoption of the creosoted red oak tie. In 1918 the use of creosoted pine ties was again begun and since that year some ties of this class have been inserted each year—a total of 860,161 having been inserted since 1918. In addition, 58,588 ties of other woods have been used since 1918, most of this number being gum and a few white oak.

There are at the present time approximately 4,130,000 ties in the tracks of the Kansas City Southern—Texarkana & Fort Smith Railways, of which approximately 2,300,000, or 57.9 per cent, are creosoted red oak and approximately 882,000, or 21.3 per cent, creosoted pine and gum, making the total percentage of creosoted ties on the system 79.2 per cent.

Form

The section foreman makes a monthly report to the Roadmaster of ties placed and removed on the form shown in Fig. 1. This form is combined in the Roadmaster's office and two copies for the entire district are forwarded to the Division Engineer, who retains one copy for his file and sends the other to the Chief Engineer. The Chief Engineer's office summarizes certain information from these forms and forwards it to the general officers interested.

It will be noted that the information on ties removed covers the mile of track, the year placed in track, the kind of tie, whether treated or untreated, whether removed from tangent or curve, main line or siding, and the cause of removal. From these reports it is possible to study any mile individually or any section individually. The operating district is the unit territory used in this study. Generally speaking, the operating district is the territory assigned to one Roadmaster, and varies from 95 miles on the Fourth District, Northern Division, to 125 miles on the First District, Southern Division. Excluding branch lines and part of the Kansas City terminal division, there are 790 miles of main line and 142 sections, making each section average 5.56 miles of main line.

Traffic

The average annual traffic of the Kansas City Southern from 1908 to 1927 inclusive, by five year periods, is given in the following tabulation. This statement is based on the statistical records of gross tons one mile per mile of road, which is given by itself and to which is added, on an estimated basis, the tons of freight locomotives and passenger trains, the freight locomotive tonnage being multiplied by 2 and the passenger locomotive tonnage being multiplied by 3 to arrive at the equated tonnage:

Table I—Average per Year—Tons 1 mile per mile—(000 omitted)

District	1908	1912	1913	1917	1918	1922	1923	1927
	Frt.G.T.	*Eq.G.T.*	*Frt.G.T.*	*Eq.G.T.*	*Frt.G.T.*	*Eq.G.T.*	*Frt.G.T.*	*Eq.G.T.*
1st Nor.	3,704	5,730	5,122	7,398	5,962	8,238	5,924	8,194
2nd Nor. ...	3,656	5,806	4,167	6,793	4,998	7,748	4,634	7,309
3rd Nor. ...	2,300	4,000	3,924	6,099	4,844	7,214	4,652	6,952
4th Nor. ...	2,376	4,342	3,494	5,706	4,044	6,384	5,036	7,596
1st Sou.	3,646	5,586	3,386	5,376	4,014	6,134	5,202	7,702
2nd Sou. ...	2,402	3,952	2,562	4,112	2,988	4,628	3,722	6,712
3rd Sou. ...	1,760	2,990	1,580	2,790	2,004	3,264	4,400	5,900
System		4,667		5,475		6,234		7,212

In the foregoing statement, locomotives are not included in freight gross tons.

Physical Characteristics

The physical characteristics of the various operating districts of the Kansas City Southern are as shown in the following table:

TABLE II—PHYSICAL CHARACTERISTICS

	Kansas City to Pittsburg	Pittsburg to Watts	Watts to Heavener	Heavener to De Queen	De Queen to S'port	S'port to Leesville	Leesville to Pt. Arthur
Mileage	122.8*	108.4	101.2	95.0	125.3	112.0	117.8
Miles curved track	24.0	31.6	26.9	35.4	19.7	20.9	7.9
Percentage curved track	19.6	29.1	24.6	37.3	15.7	18.7	6.7
Total degrees curvature	2649	4848	3229	5971	1666	2724	957
Deg. curv. per mi. line	21.6	44.7	31.9	62.8	13.3	24.3	8.1
Sum of ascents South	1481	1567	996	2040	979	1368	555
Sum of ascents North	1289	1545	1384	2213	1152	1363	775
Maximum gradient (Comp.) per cent	1.1	1.8	1.04	1.50	1.13	1.12	1.0
Mean annual rainfall (inches)	38.29	41.75	40.51	43.75	42.31	50.93	50.07
Life of untreated hardwood ties. 5 year average (years)	9.27	8.03	8.03	6.81	7.18	7.19	7.50
Max. freight locomotive axle loads—lbs.							
1908-1911	48,900	48,900	48,900	48,900	42,000	42,000	38,000
1911-1918	57,600	61,300	48,900	61,300	48,900	48,900	48,900
1918-1930	57,600	61,700	61,700	61,700	57,600	61,300	48,900

* *Tie statistics given for only 107 miles of this district.*

Rail and Ballast

First District, Northern Division—Grandview to Pittsburg.

RAIL—Laid with 85 lb. rail 1905-6; relaid with 85 lb. rail 1921-22; 25 miles relaid with 127 lb. rail 1930.

BALLAST—Chat ballast. Reballasted with chat 1915; running surface 1922.

Second District, Northern Division—Pittsburg to Watts.

RAIL—Laid with 85 lb. rail 1905-6; 30 miles relaid with 85 lb. rail 1923; 37 miles relaid with 100 lb. rail 1925; 18 miles relaid with 100 lb. rail 1929; 15 miles relaid with 127 lb. rail 1930.

BALLAST—Original ballast chert; 60 miles reballasted with chat 1915-16; 48 miles reballasted with gravel 1915-16; 46 miles reballasted with chat over gravel 1925.

Third District, Northern Division—Watts to Heavener.

RAIL—Laid with 80 lb. and 85 lb. rail 1905-6; 53 miles relaid with 85 lb. rail 1923-24-25; 49 miles relaid with 100 lb. rail 1925-26-27.

BALLAST—Original ballast chert; reballasted with gravel 1916; 55 miles reballasted with chat 1925-26.

Fourth District, Northern Division—Heavener to De Queen.

RAIL—Prior to 1906, 86 miles 80 lb. rail, 9 miles 75 lb. rail; 3 miles 75 lb. rail relaid 1912; 6 miles 75 lb. rail relaid 1915; completely relaid with 85 lb. rail 1915-16; 12 miles relaid with 85 lb. rail 1919; 35 miles relaid with 85 lb. rail 1921; 11 miles relaid with 115 lb. rail 1928; 12 miles relaid with 127 lb. rail 1928; 23 miles relaid with 100 lb. rail 1929.

BALLAST—Original ballast chert and sandstone; 81 miles reballasted with gravel 1915-16; 35 miles reballasted with gravel 1921.

First District, Southern Division—De Queen to Shreveport.

RAIL—Laid with 85 lb. rail 1908 and prior thereto; relaid with sawed second-hand 85 lb. rail 1924-29.

BALLAST—Gravel.

Third District, Southern Division—Leesville to Port Arthur.

RAIL—Original rail 60 lb.; relaid completely with 85 lb. 1910-11-12.

BALLAST—Earth, sand and oyster shell until 1915, when ballasted practically throughout with gravel; 20 miles reballasted with gravel in 1924; 55 miles reballasted with gravel in 1925.

Third District, Southern Division, Leesville to Port Arthur.

RAIL—Original rail 60 lb.; relaid completely with 85 lb. 1911-19; 48 miles relaid with 85 lb. rail 1927.

BALLAST—Earth and sand until 1913-14, when oyster shell was applied; 35 miles reballasted with gravel 1915; 40 miles reballasted with gravel 1918-19; 50 miles reballasted with gravel 1923.

Tie Plates

In 1914 an inventory developed 860,550 tie plates were in track. The number applied since that year is 3,850,662, making the present total approximately 4,711,212. The tie plates applied since 1914 have been fairly evenly spread over the intervening years and in applying them, treated pine ties, curves and treated red oak ties have been favored in the order given. The present average is something over one plate per tie, which means that approximately one-half the total number of ties are plated. However, since these have mostly been applied on the main line, it is safe to estimate that 65 per cent of the main line ties are fully plated. Since 1923 all rail laid has been on ties plated out of face.

Untreated Hardwood Ties

The tie specifications under which hardwood ties were purchased were not substantially changed, if at all, between 1908 and 1916. It is believed that under the specifications now in force, however, that the general average of ties purchased is somewhat better than those bought between 1908 and 1916. At the present time the general average is the practical equivalent of a No. 4, but from 1908 to 1916 the average was probably about a No. 3. To what extent the better ties will influence the life is problematical and unfortunately the present data sheds no light on this phase of the question.

The number of tie removals were determined by taking the monthly report of the roadmasters and assembling therefrom the number of ties of each of the years under consideration, which were removed during that month. This information was then totaled by districts and system for each year. This incurred the examination of about 25 sheets of the form shown in Fig. 1 for each month, or something over 1,000 entries per month. It was found that after the 15th year the records of removal were so few as to be negligible, with the consequence that 15 years was as far as the search was carried. In general, approximately 80 per cent of the ties placed were accounted for which, in view of heavy reconstruction work on much of the line during 1910, 1911 and 1912, with the resultant abandonment of old line, was considered satisfactory.

The charts showing the removals of untreated hardwood ties are prepared from the foregoing information by calculating the percentages of ties removed each year taking the total number accounted for as 100 per cent and accumulating the annual percentages. The average for the five years studied is shown for each district on Charts 1, 2, 3, 4, 5, 6 and 7. Chart 8 shows the average for the system for the five years studied. The system average for each of the five years considered is shown on Charts 9, 10, 11, 12 and 13. The extreme difference in these system averages is .38 years life, while the maximum over the mean is only .17 year and the minimum under the mean only .21 years.

At least three known causes contribute to the longer system life in 1916 compared with previous years.

(1) A bettered road bed and ballast condition.
(2) A reduction in the use of untreated hardwood ties on the Southern Division.
(3) A more extended use of tie plates.

Because of these facts it is probable that 7.94 years more nearly represents the present system average life than the previous years. The notable points of the data on untreated hardwood ties are:

(1) The long life on the First District, Northern Division heaviest traffic.
(2) The short life on the Fourth District, Northern Division. In this connection, attention is directed to the high percentage of curvature on this District as shown under the physical characteristics.
(3) Longer life on the Third District, Southern Division, than on the First and Second Districts, Southern Division.

Cause of Removal

It is appreciated that when a cross-tie becomes old, say an untreated hardwood tie that has been under traffic ten years, it is difficult to assign its removal to any one definite cause. In fact, the ideal condition of failure is when no specific reason is apparent. Each of the major causes of removal contributes to the other. Ties become rail cut because they are softened by decay and decay more rapidly because rail cutting exposes undecayed fiber. The following analysis of causes while taken from the removal reports cannot, therefore, be considered conclusive, but, as representing the consensus of opinion of the foremen, it deserves consideration.

Investigation of causes of removals of all untreated hardwood ties over several months, taken at random from several years insertions and covering approximately 40,000 ties, gave the following:

Removed account decay	78 per cent
Removed account rail cutting	13 per cent
Removed account broken	6 per cent
Removed account split	2 per cent
Removed account other causes	1 per cent
	100 per cent

Creosoted Red Oak Ties

Red oak is a hard, coarse grained wood which, when used for cross-ties without treatment, is short lived. Due to the coarseness of its fibrous structure, however, it is particularly susceptible to creosote treatment and when treated has the quality of a hardwood tie with its resistance to decay greatly increased. The Kansas City Southern experimented beginning with 1906 in treating pine ties. Various treatments then new and unproved were tried without sufficient success to justify any one of them. In 1909 creosoted pine ties were tried and their use continued into 1910 and 1911. These ties have given good service and it is probable that had tie plates been available and used on these ties, their extensive removals on account of rail cutting would have been greatly delayed. In 1910, after some previous experimentation,

except for creosoted pine ties already on hand or contracted for, their use was entirely abandoned for the creosoted red oak tie. Since 1910 more than two and one-half million creosoted red oak ties have been used with uniformly satisfactory results.

While some creosoted red oak ties were sent to the Northern Division in 1910 and 1911, the majority were placed on the Southern Division where climatic and roadbed conditions were severe on untreated ties. In 1912, more creosoted red oak ties were used on the Northern Division than on the Southern Division. After 1912 practically all the creosoted ties were assigned to the Southern Division until about the year 1918. Since 1925, over 90 per cent of all the ties used on the system have been treated with creosote.

Specification

The specifications for treating ties with creosote were unchanged from 1909, the date creosoted ties were first obtained, until 1927 when slight modifications were put in effect. At the present time, a mixture of creosote and coal tar is being used in the proportion of 70 per cent creosote and 30 per cent coal tar. Since this study embraces primarily the earlier ties, only the original specification is given, which reads as follows:

> "An average of 2½ gallons of creosote oil per tie is to be volume of creosote left in tie after treatment; it being understood that where the density of the wood is such as to make it impossible to inject sufficient oil to have the tie retain the said 2½ gallons that treatment of same will be to refusal. The average is based on each run or cylinder load."

Study of Results

The statistics herein given for treated ties are taken from the same reports of ties removed from track as the untreated hardwood ties. They differ from the untreated hardwood tie statistics in that all the treated ties removed on each district are taken into account and totals compiled with respect to the year placed and removed. Up to and including July, 1930, there were a total of 226,000 removals.

It was thought at the time this study was begun that some definite light would be thrown on the life of creosoted ties since a twenty year record was available on those first placed. However, only 32 per cent of those placed in 1910 have been removed and how long the remaining 68 per cent will last still belongs in the realm of speculation. The best that can be done from present data is to give the percentage of removal for each year of life. Table III shows this information in statistical form and Charts 14 and 15 show it in graphical form for the system as a whole, the Northern Division, Southern Division and the three Southern Division Districts. Table III shows the total number of creosoted oak ties removed from track with respect to the number of years' life obtained from them. For the first six years of life, fifteen years of removals are shown, and the percentage removal obtained by dividing the removals by the total of the fifteen years' insertions. The seventh year, the total removals are divided by the total of fourteen years' insertions to obtain the percentage; the eighth year removals are divided by the total of thirteen years' insertions, and so on until the twentieth year is divided by only one

TABLE III

Statement Showing Number of Removals of Treated Red-Oak Ties and Years Service Obtained – Also Percentage of Removals for each Number of Years Service & Accumulative Percentages Up to 20 Years Service for the K. C. S. Ry.-System.

Year	Number Placed.	REMOVALS 1st Yr.	2nd Yr.	3rd Yr.	4th Yr.	5th Yr.	6th Yr.	7th Yr.	8th Yr.	9th Yr.	10th Yr.	11th Yr.	12th Yr.	13th Yr.	14th Yr.	15th Yr.	16th Yr.	17th Yr.	18th Yr.	19th Yr.	20th Yr.
1910	52,051	8	—	—	—	—	—	9	10	132	859	1922	1628	1882	1509	1007	1601	1240	963	1496	1651
																					3.17%
1911	73,216	106	54	89	88	369	717	751	702	2929	2271	1350	1926	1795	1386	2358	2255	2418	2820	3035	
	125,237																			4531	3.69%
1912	121,110	350	675	118	319	41	524	1514	2898	3000	3207	3316	3790	1524	2843	3681	2541	3365	5065		
	246,347																		8848		3.59%
1913	161,078	264	119	13	62	6	204	819	2632	593	744	1618	1445	1895	2537	4858	3043	3477			
	407,425																	10,500			2.57%
1914	156,339	83	4	325	20	248	465	889	1443	1670	2542	1406	2548	4922	9314	14,378	9347				
	563,764																18,787				3.33%
1915	128,315	—	2	321	80	104	836	656	821	1186	805	1185	3326	4140	8105	7,243					
	692,079															33,525					4.85%
1916	143,470	286	8	213	95	81	247	267	1344	571	1185	1758	2409	2055	4541						
	835,549														30,235						3.62%
1917	137,870	107	134	35	64	10	542	355	438	728	1137	1414	2156	3572							
	973,419													21,785							2.24%
1918	88,067	173	—	71	61	330	35	220	1493	1176	3015	826	894								
	1,061,486												20,122								1.89%
1919	60,318	28	14	10	82	76	78	195	471	426	503	443									
	1,121,804											15,238									1.36%
1920	82,284	30	5	228	36	22	126	350	669	284	313										
	1,204,088										16,581										1.37%
1921	99,368	96	262	195	109	74	389	143	333	460											
	1,303,456									13,145											1.01%
1922	102,998	90	1	54	60	295	95	45	110												
	1,406,454								13,355												0.95%
1923	99,392	62	21	111	65	27	86	51													
	1,505,846							6,256													0.42%
1924	118,403	7	52	12	4	43	5														
	1,624,249	1674	1331	1725	1145	1727	4369														0.27%
		0.10%	0.08%	0.10%	0.07%	0.11%															
Accumulative Per C.		0.10%	0.18%	0.28%	0.35%	0.46%	0.73%	1.15%	2.10%	3.11%	4.48%	5.84%	7.73%	9.97%	13.59%	18.44%	21.77%	24.84%	27.93%	31.62%	34.79%
Sou. Div. Ac. Per C.		0.14%	0.19%	0.46%	0.53%	0.70%	1.07%	1.63%	2.98%	4.51%	6.18%	7.58%	9.28%	12.01%	16.32%	22.47%	26.58%	28.54%	32.28%	35.79%	39.31%
1st Dist. Sou. Div. Ac. Per C.		0.12%	0.19%	0.46%	0.59%	0.84%	1.20%	2.07%	3.61%	5.06%	7.32%	9.36%	12.20%	15.76%	21.34%	29.22%	35.09%	40.61%	46.53%	50.84%	50.96%
2nd " " " " " "		0.03%	0.05%	0.17%	0.24%	0.30%	0.48%	1.31%	2.59%	4.78%	6.65%	8.21%	10.22%	14.06%	21.10%	30.88%	36.04%	38.27%	41.12%	41.99%	51.05%
3rd " " " " " "		0.19%	0.29%	0.54%	0.56%	0.72%	1.07%	1.36%	2.68%	3.86%	5.24%	6.04%	7.23%	8.67%	10.34%	12.27%	14.19%	15.74%	18.27%	22.28%	30.02%

A

year's insertions—i.e., 1910. It is thought that this method is the most complete and reliable way of obtaining data on the annual rate of removals and the indication of probable life at the present time.

The insertions of creosoted red oak ties on the Northern Division were not in sufficient volume in the early years of their use to allow supportable conclusions of a worth while character to be drawn from an analysis by districts. The Northern Division is, therefore, treated as a unit and the curves representing the accumulative percentage of removals on the Northern Division, the Southern Division and the System are shown on Chart 14, while the same information for the individual districts of the Southern Division is shown on Chart 15.

In order to amplify Table III and the charts relating thereto, and to insure against the process used and results obtained being misleading, Table IV is given which shows the percentage of removals to June 30, 1930, of the ties placed each year from 1910 to 1926.

TABLE IV

Placed	*Removed to 7/1/30*	*Placed*	*Removed to 7/1/30*	*Placed*	*Removed to 7/1/30*
1910	32.4%	1916	10.8%	1922	0.7%
1911	38.0%	1917	6.3%	1923	0.4%
1912	32.0%	1918	9.4%	1924	0.1%
1913	15.1%	1919	3.9%	1925	0.2%
1914	31.7%	1920	2.5%	1926	0.1%
1915	22.5%	1921	2.1%		

Cause of Removal

In the case of creosoted red oak ties, the information as to cause of removal is more reliable and consistent than in the case of untreated hardwood ties, due to the small percentage of removals on account of decay. While it is true that a certain softening of fiber may result from age before actual decay is observable which, in a measure, contributes to rail cutting, it is far less than in the case of untreated hardwood ties. The volume of work required for examining all the removals to determine the causes made such an investigation impracticable. This phase of the study was, therefore, confined to the ties placed during 1913, 1914, 1915, and 1916 which were removed during 1929 and to June 30, 1930. The total number of ties of these four years removed during this 19 month period was 52,181 and the percentage of removals for the various causes is as follows:

Removed account decay	3.7 per cent
Removed account accident	0.7 per cent
Removed account broken	0.3 per cent
Removed account rail cutting	95.3 per cent
	100 per cent

It may be stated, in this connection, that no reports of decayed ties were observed in the entire study which had been in service less than 10 years and that practically all removals up to and including the 6th year were on account of derailments or breaking.

One of the most interesting and important features in connection with the use of treated ties is the reduction in tie renewals caused by the longer life of the treated tie. Table V shows this for the Kansas City Southern from 1908 to 1929. It will be noted that in 1910 the renewals per mile of all tracks amounted to 462.3 ties per mile which is the maximum. In 1926 the renewals had declined to 121.2 ties per mile which, until this time, has been the low point. At this rate of renewal, the average life of ties would be approximately 26 years. However, it will be noted further that in 1927 the renewals per mile rose to 127.4 and in 1928 to 143.5. It is probable that there will be a further decline from 1928 and 1929 as the percentage of treated ties increases. The low point of 1926 was due to the fact that the treated ties had not begun to fail in large numbers, only 17,598 treated oak ties being removed that year, while in 1929 the number of this class of tie removed was 39,721 and in 1930 to June 30th, approximately 40,000. The number of removals of

TABLE V

COMPARATIVE STATEMENT OF CROSS TIE RENEWALS, 1908 to 1929

Fiscal Years	Miles All Tracks Operated	Number Of Ties Renewed	Number of Treated Ties Put In Track	Percent Treated to Total Renewals	Total Renewals Per Mile Of Track
1908	1,158	407,265	140,149	34.4	351.7
1909	1,170	487,053	197,320	41.7	416.3
1910	1,196	552,915	201,699	36.5	462.3
1911	1,246	538,141	85,090	15.8	431.9
1912	1,251	367,516	44,060	11.9	293.7
1913	1,261	442,563	101,463	22.9	351.0
1914	1,273	451,763	147,927	32.7	354.9
1915	1,289	455,684	110,284	24.2	353.5
1916	1,289	435,267	126,830	29.1	337.7
1917	1,289	420,881	190,375	45.2	326.5
Calendar Years					
1917	1,290	310,038	118,274	38.1	240.4
1918	1,290	305,642	85,794	28.1	236.9
1919	1,299	354,891	214,418	60.4	273.2
1920	1,302	377,424	221,025	61.4	289.9
1921	1,308	404,949	251,452	62.1	309.6
1922	1,303	324,571	167,541	51.6	249.1
1923	1,324	299,882	175,215	58.4	226.5
1924	1,345	297,803	206,759	69.4	221.4
1925	1,378	209,161	157,874	75.5	151.8
1926	1,389	168,319	155,863	92.6	121.2
1927	1,397	177,950	164,901	92.7	127.4
1928	1,410	202,310	197,880	97.8	143.5
1929	1,420	201,809	199,176	98.7	142.1

treated ties will increase as time goes on, while the number of untreated ties removed will decline, as the percentage in track decreases. The decreases in removals of untreated ties should, in the next three to five years, more than offset the increases in removals of treated ties, after which time the number of renewals will decrease until the normal renewals for treated ties becomes established. It is now estimated that the ultimate rate of removal of treated ties will be approximately 120 ties per mile per year, or the equivalent of a 26 year life. While the data submitted herewith might be interpreted as indicating a longer average life than that, especially if the form of the curve of untreated ties is kept in mind while considering the curve for treated ties, it is also possible that the treated ties, being of more uniform character due to the treat-

ment and the resulting primary failure from causes other than natural, will be found to have a more uniform length of life, with the result that the curve of removals in the later years will turn sharply upward instead of conforming to the general characteristics of the curves for untreated ties. This is a speculative point that only time can settle, but it will be watched with interest and reported upon from time to time.

It should be pointed out that the decrease in tie renewals as shown in Table V has been accomplished under the condition of increasing speed limits of trains, the speed limits at the present time being more than twice as fast as eight to ten years ago.

With the continued use of creosoted ties, the track men have learned how these ties should be handled prior to placement and also how to care better for them when in the track. Hot creosote is now being applied to all ties re-adzed, and tie tongs are universally used in pulling ties under the rail. These factors should increase the life of the ties. However, the increased speed of trains, with added impact and vibration, tends to offset these advantages.

FIG. 1.

REPORT OF TIES PUT IN AND REMOVED FROM TRACK

On................................During Month of........................193....
(Division or District)

The purpose of this report is to determine the life of ties, and only ties inserted or removed in making renewals should be reported. Do not show treated and untreated ties nor more than one kind of timber, on the same line. Report cross and switch ties used in renewals only, excluding ties released in removal of tracks, displacement of cross-ties by switch ties in construction of new tracks, and similar work. Show totals by Roadmasters' districts.

Signed ....

Title ....

Mile	Name of Track	Number of Untreated Ties	Number of Treated Ties	Kind of Treatment	Kind of Timber

Mile	Name of Track	Tangent or Curve	Year Put in Track	Number of Untreated Ties	Number of Treated Ties	Kind of Treatment	Kind of Timber	Why Removed

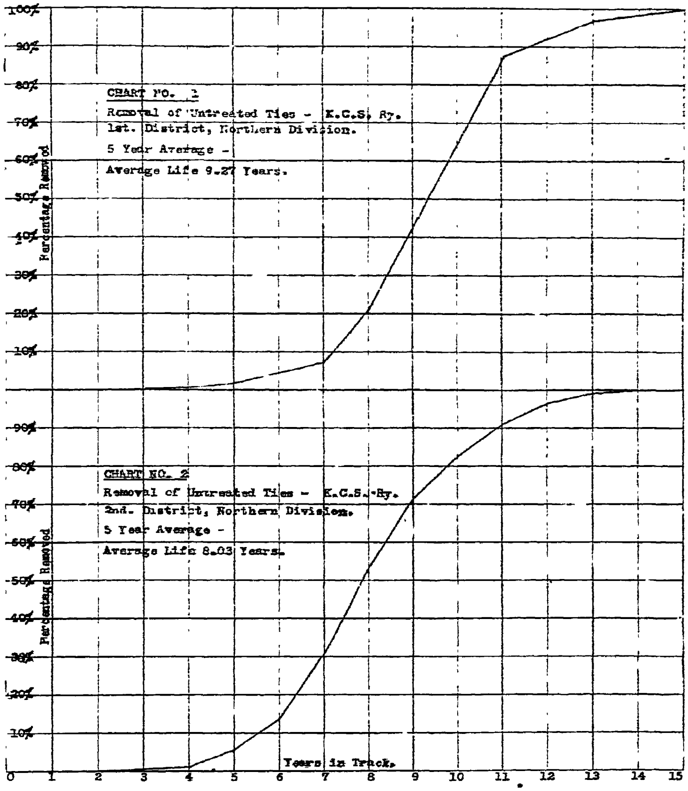


CHART NO. 1
Removal of Untreated Ties - K.C.S. Ry.
1st. District, Northern Division.
5 Year Average -
Average Life 9.27 Years.
CHART NO. 2
Removal of Untreated Ties - K.C.S. Ry.
2nd. District, Northern Division.
5 Year Average -
Average Life 8.03 Years.
Percentage Removed
Years in Track.
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

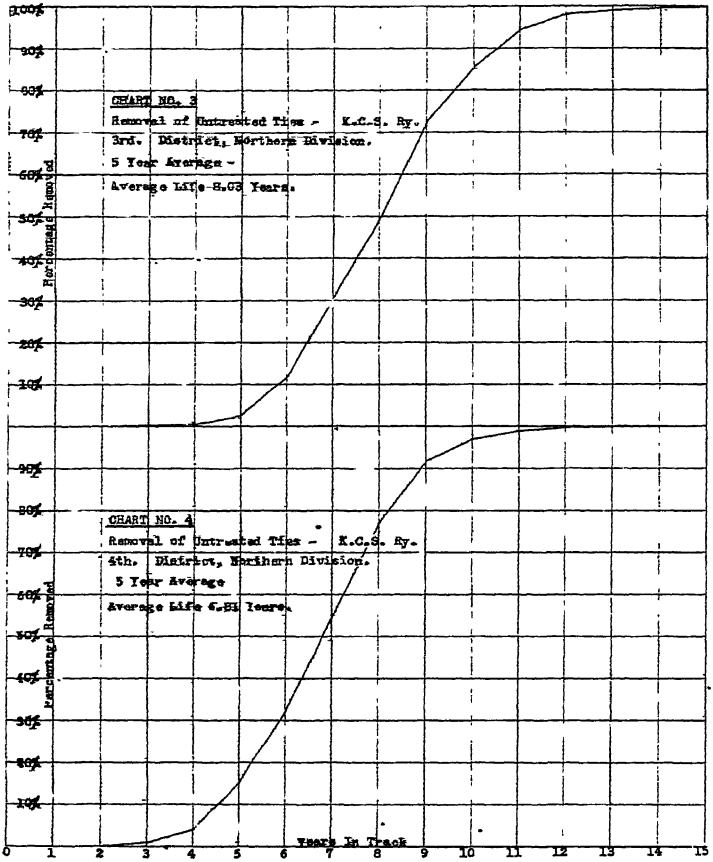


CHART NO. 3
Removal of Untreated Ties - K.C.S. Ry.
3rd. District, Northern Division.
5 Year Average -
CHART NO. 4
Removal of Untreated Ties - K.C.S. Ry.
4th. District, Northern Division.
5 Year Average
Percentage Removed
Years In Track
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

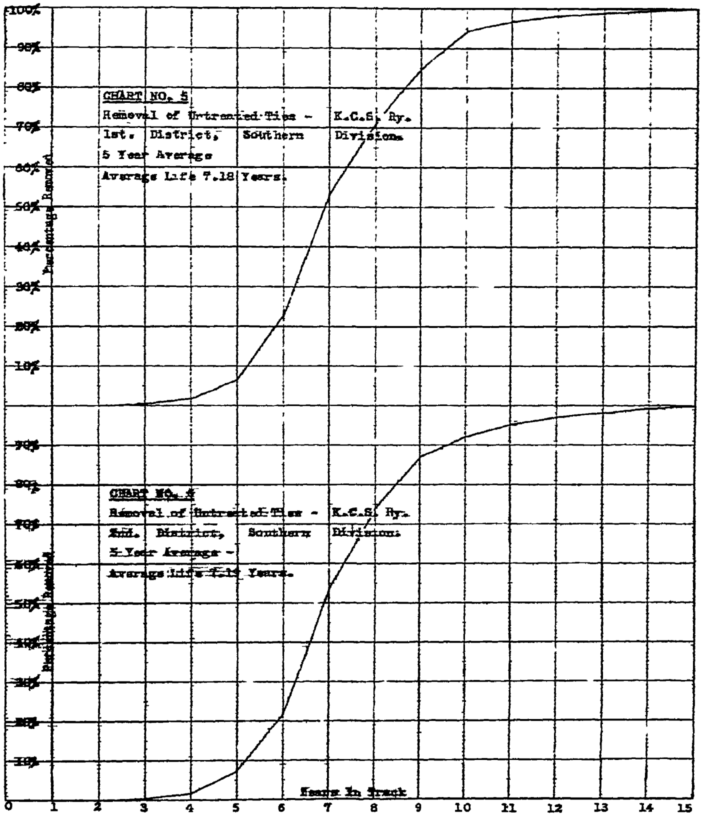
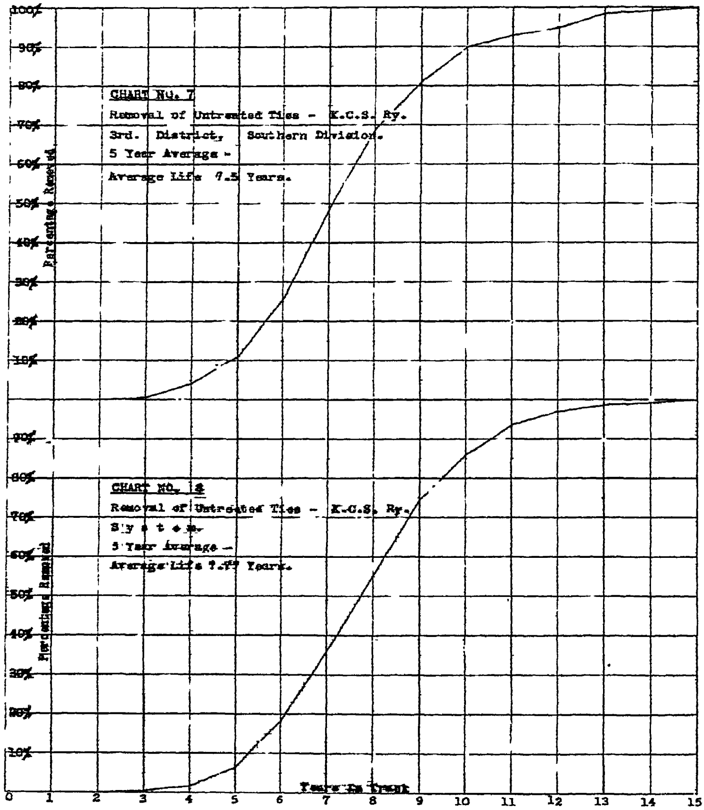


CHART NO. 5
Removal of Untreated Ties - K.C.S. Ry.
1st. District, Southern Division.
5 Year Average
Average Life 7.18 Years.
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
Percentage Removed
K.C.S. Ry.
Southern
5 Year Average -
Years.
Years in Track
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
Percentage Removed
CHART NO. 7
Removal of Untreated Ties - K.C.S. Ry.
3rd. District, Southern Division.
5 Year Average -
Average Life 7.5 Years.
90%
80%
70%
60%
50%
40%
30%
20%
10%
Percentage Removed
CHART NO.
Removal of Untreated Ties - K.C.S. Ry.
System.
5 Year Average -
Years in Track
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

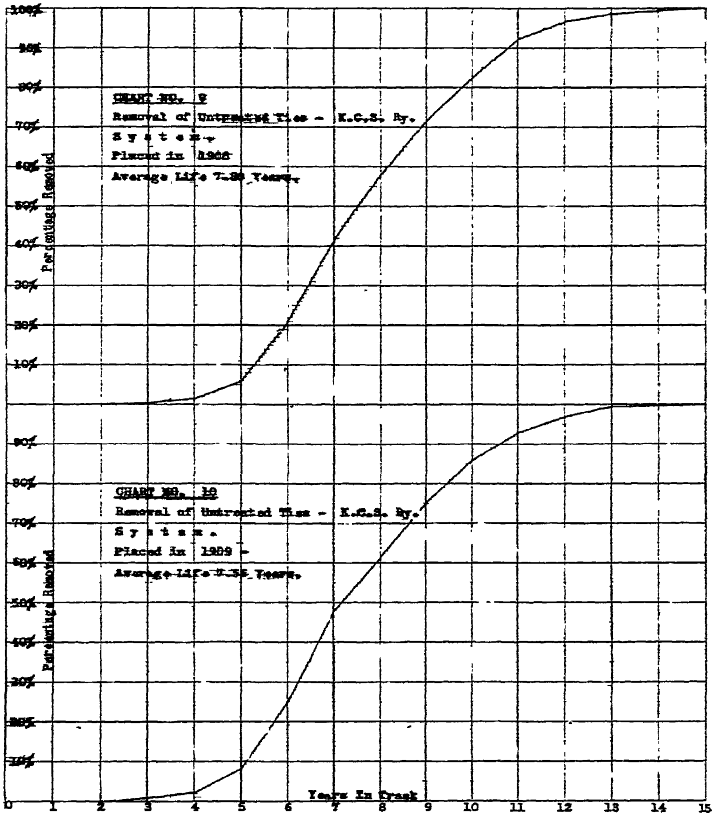


CHART NO. 9
Removal of Untreated Ties - K.C.S. Ry.
System.
CHART NO. 10
Removal of Untreated Ties - K.C.S. Ry.
System.
Placed in 1909
Percentage Removed
Years In Track
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

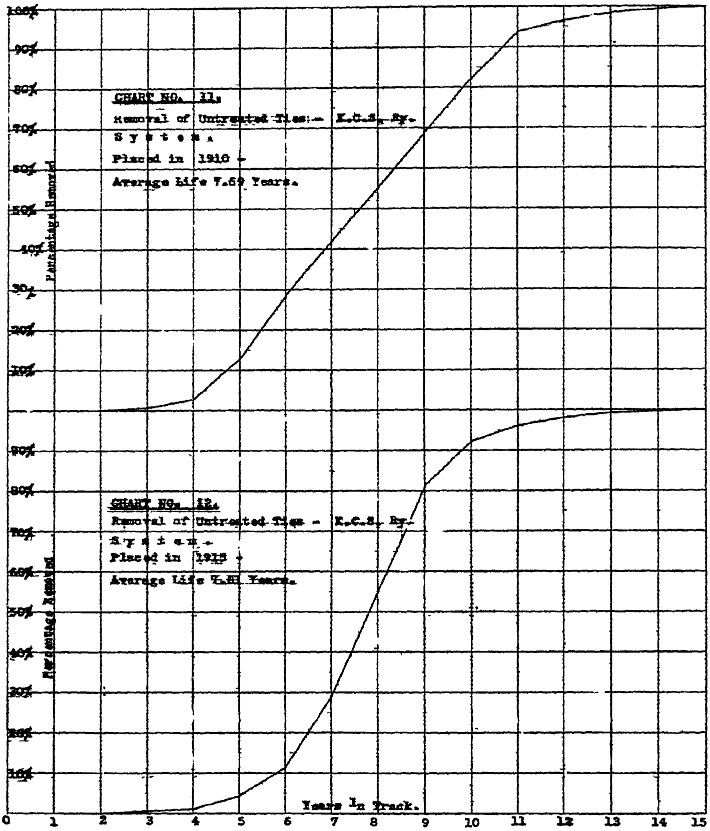


CHART NO. 11.
Removal of Untreated Ties:- K.C.S. Ry.
System.
Placed in 1910 -
Average Life 7.69 Years.
CHART NO. 12.
Removal of Untreated Ties - K.C.S. Ry.
System.
Placed in 1915 -
Percentage Removed
Years In Track.
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

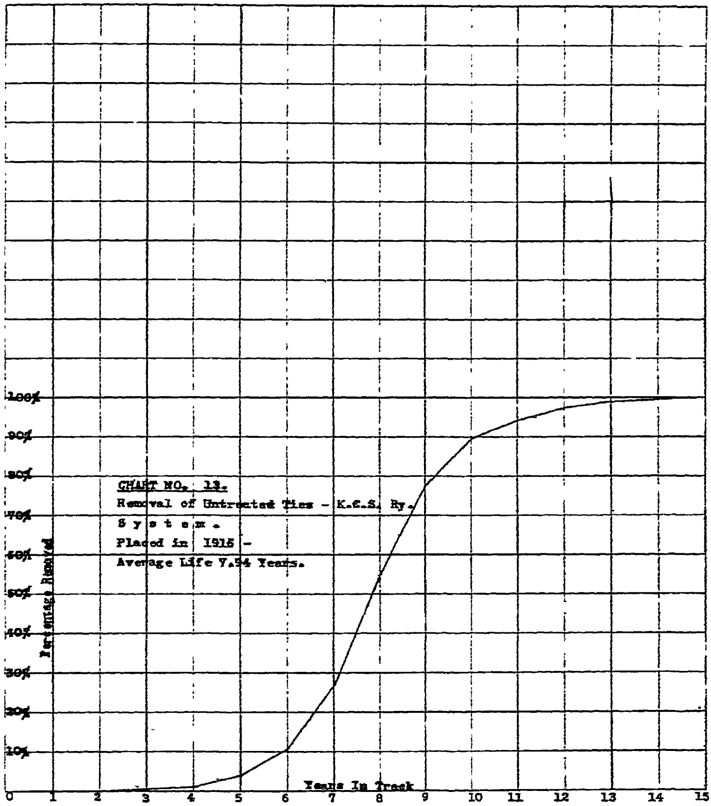


CHART NO. 13.
Removal of Untreated Ties - K.C.S. Ry.
S y s t e m.
Placed in 1916 -
Average Life 7.94 Years.
Percentage Removed
Years In Track
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

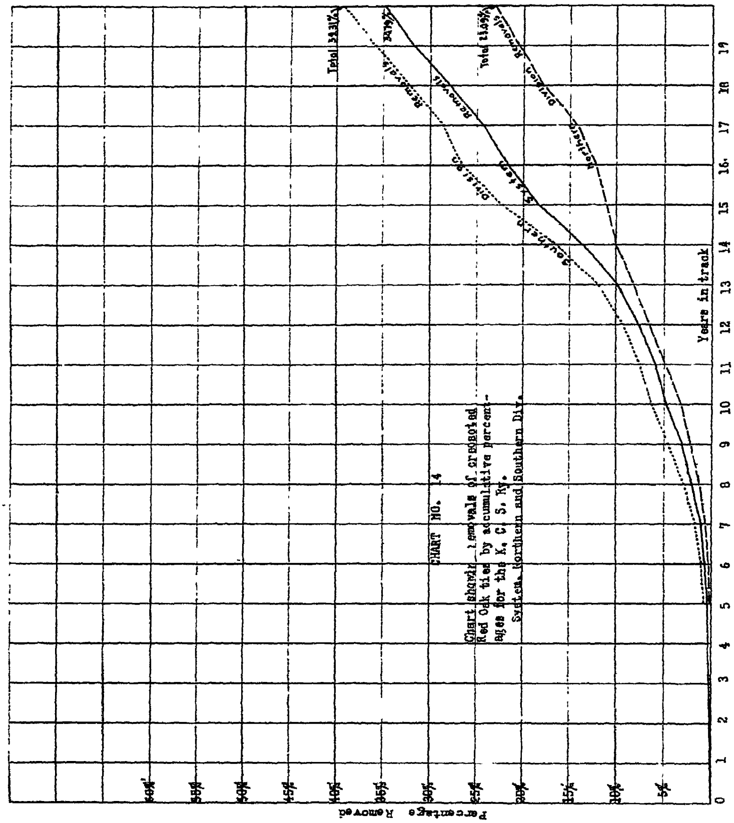


CHART NO. 14
Chart showing removals of creosoted Red Oak ties by accumulative percentages for the K. C. S. Ry. System, Northern and Southern Div.
Total 34.31%
34.79%
Total 21.59%
Southern Division Removals
System Removals
Northern Division Removals
Years in track
Percentage Removed
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
5% 10% 15% 20% 25% 30% 35% 40% 45% 50% 55% 60%

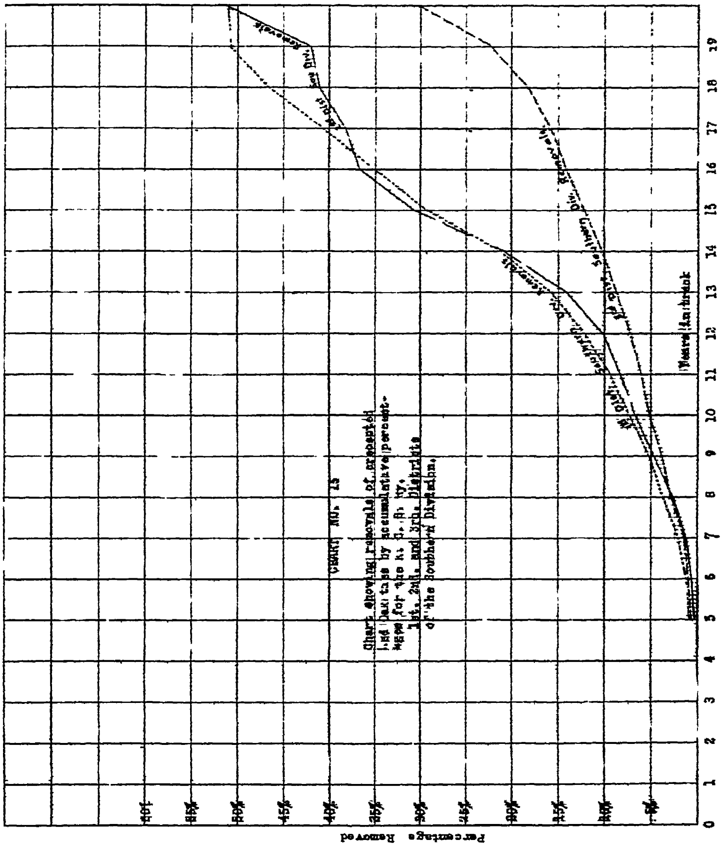


CHART NO. 15
Percentage Removed

REPORT OF COMMITTEE XVII—WOOD PRESERVATION

F. C. SHEPHERD, *Chairman;*
WM. G. ATWOOD,
R. S. BELCHER,
Z. M. BRIGGS,
WALTER BUEHLER,
C. S. BURT,
H. R. CONDON,
C. C. COOK,
E. A. CRAFT,
J. F. DONOVAN,
H. R. DUNCAN,
E. B. FULKS,
W. R. GOODWIN,
L. H. HARPER,
L. B. HOLT,
G. R. HOPKINS,
H. E. HORROCKS,
R. S. HUBLEY,
C. F. FORD, *Vice-Chairman;*
M. F. JAEGER,
W. H. KIRKBRIDE,
W. T. MACCART,
G. P. MACLAREN,
F. D. MATTOS,
CLYDE OSBORNE,
J. H. REEDER,
L. J. REISER,
L. B. SHIPLEY,
O. C. STEINMAYER,
G. C. STEPHENSON,
T. H. STRATE,
C. M. TAYLOR,
DR. H. VON SCHRENK,
C. S. WILTSEE, JR.,
GALEN WOOD,

Committee.

To the American Railway Engineering Association:

Your Committee respectfully presents herewith report covering the following subjects:

(1) Service Test Records for Treated Ties (Appendix A).

(2) Piling Used for Marine Construction (Appendix B).

(3) Destruction by Termite and Possible Ways of Preventing Same (Appendix C).

(4) Practicability of Boring Bridge and Switch Ties for Spikes before Treatment (Appendix D).

Action Recommended

1. That the information contained in Appendix A—Service Test Records for Treated Ties; Appendix B—Piling Used for Marine Construction, and Appendix C—Destruction by Termite and Possible Ways of Preventing Same, be accepted as information.

2. That the conclusions in Appendix D—Practicability of Boring Bridge and Switch Ties for Spikes before Treatment, be approved for publication in the Manual.

Respectfully submitted,

THE COMMITTEE ON WOOD PRESERVATION,

F. C. SHEPHERD, *Chairman.*

Bulletin 332, December, 1930.

Appendix A

(1) SERVICE TEST RECORDS FOR TREATED TIES

W. R. Goodwin, Chairman, Sub-Committee; Z. M. Briggs, C. S. Burt, L. B. Holt, R. S. Hubley, G. P. MacLaren, W. T. MacCart, J. H. Reeder, T. H. Strate.

The table of tie renewals per mile maintained on various railroads has been brought up to include renewals for 1929.

Reports are submitted covering special test tracks on the Chicago, Burlington & Quincy, Chicago, Milwaukee, St. Paul & Pacific, Chicago & Northwestern, Great Northern, Rock Island, St. Louis & Southwestern and Soo Line (M., St. P. & S. S. M. Ry.).

REPORT ON INSPECTION OF C., B. & Q. TEST TIES AFTER 20 YEARS' SERVICE

The experimental tracks of the Chicago, Burlington & Quincy Railroad furnish one of the most interesting and valuable records of service of treated and untreated ties in this country. This railroad is one of the oldest users of treated ties, having begun their use some thirty years ago. The year 1907 marks the beginning of their installation of treated ties on an extensive scale and around three million treated ties are now installed by them annually.

Average Life of Untreated Ties (in years)

Cottonwood	3.0	Red Gum	4.0	Tamarack	5.3	Hickory	5.8
Tupelo Gum	3.3	Hard Maple	4.8	Ash	5.4	Pin Oak	6.6
Sycamore	3.4	Beech	5.0	Loblolly Pine	5.4	Cypress	7.2
Red Birch	3.9	Hemlock	5.2	Poplar	5.5	Chestnut	8.7
Soft Maple	3.9	Red Oak	5.2	White Elm	5.6	White Oak	10.8

Several experimental test tracks were laid in 1909 and 1910 to obtain information on the relative durability of ties of various species untreated and treated with standard preservatives. These tracks have been inspected regularly each year and the reports of these inspections are significant of the comparative value of various preservative treatments and of the ultimate economy of preservative treatment of ties.

These ties were laid on twenty divisions in eight states, and all were placed out of face. Ties on the western lines were laid with comparatively small tie plates, and on the eastern lines a considerable number were not equipped with tie plates when laid, but were tie-plated after three or four years' service.

The results of the 1929 inspection are given in the accompanying tables, taken from the annual report of H. R. Duncan, Superintendent of Timber Preservation.

Summary of 1929 Inspection of Crosstie Test Tracks C. B. & Q. R. R. Results of 20 Years' Service

Process	LINES EAST				LINES WEST			
	Total Placed	*Total removed to date*	*Per cent removed account decay*	*Per cent removed a/c other causes*	*Total Placed*	*Total removed to date*	*Per cent removed a/c decay*	*Per cent removed a/c other causes*
Creosote	2,045	669	12	21	1,236	551	12	32
Card	10,244	6,332	24	38	5,593	4,089	27	46
Burnett	1,578	1,269	50	31	909	845	43	49
Untreated	2,045	2,036	90	9	1,225	1,221	90	9

NOTE: These percentages include only the ties placed in what are termed the thousand-tie lots on the various divisions.

Ash Ties								
Creosote	19	16	26	58	16	10	25	38
Card	289	194	15	53	103	74	19	53
Burnett	16	11	38	31	15	13	33	54
Untreated	70	70	99	1	45	45	100	...
Beech Ties								
Creosote	321	52	4	12	162	34	2	19
Card	807	582	35	37	420	341	34	47
Burnett	200	167	51	33	105	94	50	40
Untreated	134	134	98	2	74	73	96	3
Birch Ties								
Creosote	75	24	24	8	59	24	14	27
Card	715	465	30	35	360	255	30	41
Burnett	83	83	60	40	30	30	43	57
Untreated	139	139	100	...	78	78	100	...
Chestnut Ties								
Creosote		...	...	...	...	...	...	...
Card	164	158	15	81	89	89	6	94
Burnett		...	...	...	...	...	...	...
Untreated	169	167	34	64	90	90	22	78
Cottonwood Ties								
Creosote	88	25	1	27	45	13	11	20
Card	296	184	20	43	160	120	19	56
Burnett		...	...	...	...	...	...	...
Untreated	56	56	95	5	30	30	100	...
Cypress Ties								
Creosote	25	3	...	12	29	18	41	21
Card	409	248	9	52	254	181	23	48
Burnett	25	13	8	44	30	28	43	50
Untreated	135	132	78	20	90	89	88	11

Summary of 1929 Inspection of Crosstie Test Tracks C. B. & Q. R. R.—Continued

Process	LINES EAST				LINES WEST			
	Total Placed	*Total removed to date*	*Per cent removed account decay*	*Per cent removed a/c other causes*	*Total Placed*	*Total removed to date*	*Per cent removed a/c decay*	*Per cent removed a/c other causes*
Elm Ties								
Creosote	208	54	15	12	120	37	7	23
Card	594	295	18	31	371	214	23	35
Burnett	224	145	42	22	73	66	55	36
Untreated	113	113	93	7	78	78	96	4
Hemlock Ties								
Creosote	136	85	24	39	99	66	19	47
Card	816	555	23	45	488	413	35	50
Burnett	125	92	38	25	87	77	32	56
Untreated	112	112	100	...	78	78	99	1
Hickory Ties								
Creosote	10	2	10	10	15	6	7	33
Card	185	153	29	54	105	88	39	25
Burnett	9	3	...	33	15	14	47	47
Untreated	65	65	91	9	45	45	100	...
Pine Ties, Loblolly or Sap								
Creosote	145	47	6	27	72	49	17	51
Card	949	526	26	29	386	293	24	52
Burnett	128	125	73	24	72	69	45	51
Untreated	157	157	99	1	91	91	100	...
Hard Maple Ties								
Creosote	82	17	13	7	34	16	3	44
Card	561	274	22	27	272	189	28	41
Burnett	50	30	36	24	15	15	87	13
Untreated	76	76	97	3	45	45	100	...
Soft Maple Ties								
Creosote	139	77	30	25	62	28	21	24
Card	462	333	37	35	264	166	19	44
Burnett	125	121	66	31	57	55	35	61
Untreated	82	82	100	...	43	43	95	5
White Oak Ties								
Creosote	25	2	...	8	15	9	20	40
Card	234	171	33	40	152	125	26	56
Burnett	28	23	61	21	15	15	40	60
Untreated	81	78	85	11	44	43	80	18

Summary of 1929 Inspection of Crosstie Test Tracks C. B. & Q. R. R.—Continued

	LINES EAST				LINES WEST			
Process	*Total Placed*	*Total removed to date*	*Per cent removed account decay*	*Per cent removed a/c other causes*	*Total Placed*	*Total removed to date*	*Per cent removed a/c decay*	*Per cent removed a/c other causes*
				RED OAK TIES				
Creosote	165	41	4	21	120	50	12	30
Card	776	426	16	39	508	424	31	53
Burnett	158	119	44	31	116	104	38	52
Untreated	129	129	96	4	75	74	92	7
				PIN OAK TIES				
Creosote	189	43	6	17	132	28	8	14
Card	513	209	13	27	321	197	19	42
Burnett	23	7	17	13	44	41	30	64
Untreated	81	80	96	3	45	45	96	4
				POPLAR TIES				
Creosote	50	16	8	24	30	24	17	63
Card	396	312	31	48	253	210	34	49
Burnett	50	39	46	32	30	30	57	43
Untreated	81	81	93	7	45	45	98	2
				RED GUM TIES				
Creosote	89	50	22	34	48	30	23	40
Card	429	242	25	31	233	142	30	31
Burnett	75	72	64	32	43	41	70	26
Untreated	98	98	97	3	54	54	98	2
				SYCAMORE TIES				
Creosote	75	18	13	11	15	2	...	13
Card	399	213	37	16	121	107	61	27
Burnett	75	72	80	16	15	15	80	20
Untreated	81	81	98	2	50	50	96	4
				TAMARACK TIES				
Creosote	106	52	7	42	108	81	14	61
Card	813	606	20	55	496	401	29	52
Burnett	108	81	31	44	106	97	27	65
Untreated	98	98	96	4	77	77	100	...
				TUPELO GUM TIES				
Creosote	98	45	18	28	54	26	15	33
Card	437	186	13	30	237	60	11	14
Burnett	76	66	40	47	41	41	61	39
Untreated	88	88	99	1	48	48	98	2

GREAT NORTHERN RAILWAY

Record of Test Ties

Belt to Gerber, Montana
Butte Division

(Ties treated 1910—Track laid Spring of 1911)

Kind of Ties	*Number of ties originally placed*	*Number now in service*	*Number removed from all causes*	*Per cent removed to date*	*Average life of test ties*
Untreated Ties—(Various types and timbers)					
Pine—Sawed Triangular	2010	None	2010	100	
Pine—Slabbed	1145	None	1145	100	
Tamarack—Sawed Triangular	1836	None	1836	100	
Tamarack—Sawed Square....	1277	None	1277	100	
Tamarack—Slabbed	1236	None	1236	100	
Fir—Sawed Triangular	1978	None	1978	100	
Fir—Slabbed	1340	None	1340	100	
Total	10822	None	10822	100	7.5 Years
4 Per Cent Zinc Chloride Treatment—(½ lb. per cu. ft.)					
Pine-Sawed Triangular	1974	262	1712	87	16
Pine-Sawed Square	1327	130	1197	90	15
Pine-Hewed	3328	478	2850	86	16
Tamarack-Sawed Triangular..	1887	322	1565	83	16
Tamarack-Sawed Square	1318	328	990	75	17
Tamarack-Slabbed	1273	767	506	40	21
Fir-Sawed Triangular	1635	410	1225	75	117
Fir-Sawed Square	928	180	748	80	17
Fir-Slabbed	1286	409	877	68	18
TOTAL	14956	3286	11670	78	17
6 Per Cent Zinc Chloride Treatment (¾ lb. per cu. ft.)					
Pine-Sawed Triangular	2004	521	1483	74	17
Pine-Sawed Square	1367	189	1178	86	16
Tamarack-Sawed Triangular ..	2084	1223	861	41	21
Tamarack-Slabbed	1433	812	621	43	21
Fir-Sawed Triangular	1988	405	1583	80	17
Fir-Sawed Square	819	195	624	76	17
Fir-Slabbed	1274	358	916	72	18
TOTAL	10969	3703	7266	66	18
Creosoted Ties (12 lb. per cu. ft. treatment)					
Fir-Hewed	2938	None	2938	100	
Fir-Square Sawed	3453	184	3269	95	14
TOTAL	6391	184	6207	97	13
Summary					
Untreated	10822	None	10822	100	7.5
4% Zinc Chloride	14956	3286	11670	78	17
6% Zinc Chloride	10969	3703	7266	66	18
Creosoted	6391	184	6207	97	13
TOTAL	43138	7173	35965	83	16

NOTE—The Fir ties treated with Creosote received no air seasoning but were artificially seasoned by steaming before treatment. These Creosoted ties began early to check and split badly and went all to pieces, there being no sign of decay on any part of the tie when removed. In 9 years service 90 per cent of the Creosoted ties had to be removed from track. The fibre of the wood no doubt was destroyed due to excessive steaming before treatment.

MINNEAPOLIS, ST. PAUL & SAULT STE. MARIE RAILWAY COMPANY

"SOO LINE"

In September, 1927, the Soo Line Railway installed a Test Track at Waukesha, Wis. The test consists of Maple, Beech, Yellow Birch, White Birch, Red Oak, and Elm ties. Each variety of timber has 150 ties treated with 6 lb. of A.R.E.A. No. 1 Creosote and the same number treated with ½ lb. of Zinc Chloride per cubic foot. All ties were adzed and bored before treatment, and are laid under 100 lb. rail and tie plated. There are also in this test 150 ties each of Yellow Birch, Beech and Red Oak treated ties with 8 lb. per cubic foot of No. 1 Creosote, and 150 ties each of Maple, Elm and White Birch with 9 lb. per cubic feet of No. 1 Creosote.

ROCK ISLAND LINES

SPECIAL REPORT OF TIES IN TEST SECTIONS—FALL INSPECTION 1929
CREOSOTED TIES "RUEPING" PROCESS—1908 TO 1912 INCLUSIVE

Divisions	Location	Kind of Ties	Year	Number of Ties		Per Cent Re-moved	Av. Life Yrs. End 1929	Estimated Av. Life Yrs. *
				Inserted	Remaining in Track			
Okla. So.	Okarche, Okla.	Gum	1912	203	150	26	16.7	20.9
El. P. Am.	Dalhart, Tex.	Pine	1912	570	431	24	16.0	21.2
Ark. La.	Ola, Ark.	Pine	1912	1,252	773	38	15.9	19.5
P. H. I. T.	Yukon, Okla.	Pine	1912	1,579	376	76	14.1	15.6
Okla. So.	Chico, Tex.	Pine	1912	946	726	23	16.1	21.5
Total		Pine	1912	4,347	2,306	47	15.3	18.4

* Estimated average life based on Forest Products Laboratory Curve.
Note: "Reuping" treated ties covered by this report were more or less damaged by railwear prior to the application of tie plates.

Conclusion

It is recommended that this report be accepted as information and the subject continued.

ST. LOUIS SOUTHWESTERN RAILWAY COMPANY OF TEXAS

Report of Inspection of Experimental Cross Ties in Track South of Texarcana as Made on October 15th, 1929

Office of Chief Engineer

Tyler, Texas, December 10th, 1929

Test Section	A	B	C	D	E	F	G	H	I	J	K
Species of timber	Dry Loblolly Pine	Green Loblolly Pine	Dry Short Leaf Pine	Dry Long Leaf Pine	Green Long Leaf Pine	Green Short Leaf Pine	Red Oak	White Oak	Dry Red Oak	Dry Short Leaf Pine	Dry Loblolly Pine
Where Grown	Doddridge, Ark.	Deweyville, Tex.	Doddridge, Ark.	Hornbeck, La.	Hornbeck, La.	Doddridge, Ark.	Converse, La.	Roberts, Ark.	Maud, Texas	Bowie Co., Texas	Bowie Co., Texas
Form	Hewed	Hewed	Hewed	Hewed	Hewed	Hewed	Hewed	Hewed	Hewed	Hewed	Hewed
Dimensions	6"x8"x8'0"	6"x8"x8'0"	6"x8"x8'0"	6"x8"x8'0"	6"x8"x8'0"	6"x8"x8'0"	6"x8"x8'0"	6"x8"x8'0"	6"x8"x8'0"	6"x8"x8'0"	6"x8"x8'0"
Where set in main line			South of Tex	arkana, Tex.,	on Mile 419 a	nd 420					
Date Set	July 1910	July 1910	July 1910	July 1910	July 1910	July 1910	July 1910	July 1910	Dec. 1911	Dec. 1911	Dec. 1911
Curve or Tangent	Tangent	Curve and Tangent	Tangent	Tangent	Tangent	2°Curve	Tangent	Tangent	2°Curve	Tangent	Tangent
Grade of Track	1 per cent	1 per cent	1 per cent	1 per cent	0.5 per cent	Level	0.5 per cent	Vertical crv.	Level	Level	Vertical Crv
Number of Ties set	292	299	263	300	300	300	200	200	200	100	100
Spacing in track (per mi.)	3,168	3,168	3,168	3,168	3,168	3,168	3,168	3,168	3,168	3,168	3,168
Preparation (Seasoned)	Seasoned	Unseasoned	Seasoned	Seasoned	Unseasoned	Unseasoned	Seasoned	Seasoned	Seasoned	Seasoned	Seasoned
Preservative	Creosote	Creosote	Creosote	Creosote	Creosote	Creosote	Creosote	Creosote	Creosote	Allardyce	Allardyce
Process	No steam	Steamed	No steam	No steam	Steam	Steam	No steam	No Steam	No Steam	No Steam	No Steam
Average absorption per tie	32#	32#	32#	32#	32#	32#	18.948#	20.5#	20.74#	----------	----------
Average absorption per cubic foot	12#	12#	12#	12#	12#	12#	7.1056#	70.69#	7.8#	----------	----------
Tie plates—kind	None	None	None	None	None	None	None	None	None	None	None
Tie plates—size											
Ballast	Gravel	Gravel	Gravel	Gravel	Gravel	Gravel	Gravel	Gravel	Gravel	Gravel	Gravel
Weight of rail per yard*	85#	85#	85#	85#	85#	85#	85#	85#	85#	85#	85#
Spikes	Cut	Cut	Cut	Cut	Cut	Cut	Cut	Cut	Cut	Cut	Cut
Date Inspected	10-15-29	10-15-29	10-15-29	10-15-29	10-15-29	10-15-29	10-15-29	10-15-29	10-15-29	10-15-29	10-15-29
Number of ties OK	33	18	15	50	39	17	5	15	17	0	1
Number ties defective	108	109	125	171	197	147	68	24	109	43	25
Number ties taken out	151	172	123	79	64	136	127	161	74	57	74
Percent ties OK	11	6	5	17	13	6	2	7	8	0	1
Percent ties defective	37	36	47	56	66	49	34	12	55	43	25
Percent ties taken out	52	58	48	27	21	45	64	81	37	57	74

*Rail was laid in 1920, releasing 75# rail.

ROCK ISLAND LINES

Special Report of Ties in Test Sections—Fall Inspection 1929
Creosoted Ties "Rueping" Process—1908 to 1912 Inclusive

Divisions	Location	Kind of Ties	Year	Number of Ties		Per Cent Removed	Av. Life Yrs. End 1929	Estimated Av. Life Yrs.*
				Inserted	Remaining in Track			
El. P. Am.	McLean, Tex.	Gum	1908	264	112	57	18.1	20.4
El. P. Am.	McLean, Tex.	Pine	1908	1,819	568	68	17.3	20.1
Okla. So.	Chico, Tex.	Pine	1908	710	307	56	17.1	21.6
Total		Pine	1908	2,529	875	65	17.2	20.5
Ark. La.	Ola, Ark.	R. Oak	1909	728	266	63	17.6	19.8
P. H. I. T.	Yukon, Okla.	R. Oak	1909	649	132	79	16.9	18.1
Total		R. Oak	1909	1,377	398	71	17.3	18.9
Ark. La.	Ola, Ark.	Gum	1909	76	24	68	16.7	19.2
Ark. La.	Leola, Ark.	Gum	1909	385	80	79	14.9	18.1
P. H. I. T.	Yukon, Okla.	Gum	1909	546	353	35	18.7	23.2
Okla. So.	Okarche, Okla.	Gum	1909	71	45	36	19.1	23.2
Total		Gum	1909	1,078	502	53	17.2	21.0
Ark. La.	Ola, Ark.	Pine	1909	1,012	235	76	16.4	18.3
Ark. La.	Leola, Ark.	Pine	1909	1,324	182	86	15.0	17.3
P. H. I. T.	Yukon, Okla.	Pine	1909	1,586	200	87	14.5	17.2
Okla. So.	Okarche, Okla.	Pine	1909	380	63	83	15.8	17.7
Okla. So.	Chico, Tex.	Pine	1909	2,386	1,119	53	16.8	21.0
Total		Pine	1909	6,688	1,799	73	15.8	18.6
Kansas	Topeka, Kans.	R. Oak	1910	1,237	704	43	17.7	21.1
Ark. La.	Ola, Ark.	R. Oak	1910	68	29	57	16.4	19.3
Total		R. Oak	1910	1,305	733	43	17.6	21.1
Ark. La.	Leola, Ark.	Gum	1910	80	13	83	13.6	16.8
Okla, So.	Okarche, Okla.	Gum	1910	73	45	38	18.4	21.8
Total		Gum	1910	153	58	62	15.9	19.0
Kansas	Topeka, Kan.	Pine	1910	501	269	46	17.9	20.8
Ark. La.	Ola, Ark.	Pine	1910	430	61	86	15.1	16.5
Ark. La.	Leola, Ark.	Pine	1910	1,861	180	90	13.7	15.1
P. H. I. T.	Yukon, Okla.	Pine	1910	1,003	360	64	16.3	18.6
Okla. So.	Okarche, Okla.	Pine	1910	749	399	46	17.3	20.8
Total		Pine	1910	4,544	1,269	72	15.4	17.7
Kansas	Topeka, Kan.	R. Oak	1911	864	465	46	16.4	19.7
El. P. Am.	McLean, Tex.	R. Oak	1911	517	392	24	17.4	22.5
Ark. La.	Ola, Ark.	R. Oak	1911	42	18	57	16.8	18.3
P. H. I. T.	Yukon, Okla.	R. Oak	1911	416	55	86	14.7	15.6
Okla. So.	Okarche, Okla.	R. Oak	1911	149	108	27	17.1	22.2
Total		R. Oak	1911	1,988	1,038	48	16.3	19.5
Ark. La.	Ola, Ark.	Gum	1911	65	24	63	15.7	17.8
Okla. So.	Okarche, Okla.	Gum	1911	146	94	35	17.4	20.9
Total		Gum	1911	215	118	45	16.9	19.7
Kansas	Topeka, Kans.	Pine	1911	180	109	39	17.3	20.4
Ark. La.	Ola, Ark.	Pine	1911	4,406	704	84	15.4	15.8
Ark. La.	Leola, Ark.	Pine	1911	277	33	88	14.0	15.3
P. H. I. T.	Yukon, Okla.	Pine	1911	1,406	401	71	14.9	16.9
Okla. So.	Okarche, Okla.	Pine	1911	977	427	56	16.0	18.5
Okla. So.	Chico, Tex.	Pine	1911	1,054	1,290	37	16.5	20.6
Total		Pine	1911	9,300	2,964	68	15.6	17.3
El. P. Am.	McLean, Tex.	R. Oak	1912	152	88	42	14.8	19.1
P. H. I. T.	Yukon, Okla.	R. Oak	1912	373	69	81	14.5	15.1
Total		R. Oak	1912	525	157	70	14.5	16.1

ROCK ISLAND LINES

Special Report of Ties in Test Sections—Fall Inspection 1929
Creosoted Ties "Lowry" Process (1907 to 1912 Inclusive)

Divisions	Location	Kind of Ties	Year	Number of Ties: Inserted	Number of Ties: Remaining in Track	Per Cent Removed	Av. Life Yrs. End 1929	Estimated Av. Life Yrs.*
C. R. Minn.	Clarksville, Ia.	R. Oak	1907	345	246	28	20 9	27.5
		Gum	1907	99	59	40	19.4	25.0
Illinois	Tiskilwa, Ill.	R. Oak	1908	514	203	61	18.3	20.7
Iowa	Altoona, Ia.	R. Oak	1908	477	342	28	19.7	26.2
C. R. Minn.	Ely, Ia.	R. Oak	1908	1,178	726	38	18.8	24.1
	Clarksville, Ia.	R. Oak	1908	1.641	999	38	19.5	24.1
Dakota	West Bend, Ia.	R. Oak	1908	149	86	42	18.9	23.5
Missouri	Princeton, Mo.	R. Oak	1908	215	70	67	16.8	20.1
Neb. Colo.	Fairbury, Neb.	R. Oak	1908	502	375	25	19.9	26.9
	Goodland, Kans.	R. Oak	1908	87	83	4	20.9	**
	Total	R. Oak	1908	4,763	2,884	39	19.1	24.1
Illinois	Tiskilwa, Ill.	Gum	1908	71	22	69	16.0	20.0
Missouri	E. Des Moines, Ia.	Gum	1908	99	66	33	18.5	25.9
C. R. Minn.	Ely, Ia.	Gum	1908	391	186	52	17.2	22.1
	Clarksville, Ia.	Gum	1908	95	54	43	18.8	23.3
Dakota	West Bend, Ia.	Gum	1908	887	657	26	19.4	26.5
Neb. Colo.	Fairbury, Neb.	Gum	1908	114	50	56	18.7	21.6
	Total	Gum	1908	1,657	1,035	37	18.6	24.4
Illinois	Tiskilwa, Ill.	R. Oak	1909	1,340	760	43	18.3	22.2
Iowa	Altoona, Ia.	R. Oak	1909	1.445	1,167	19	18.6	27.0
C. R. Minn.	Ely, Ia.	R. Oak	1909	971	691	29	18.8	24.6
	Clarksville, Ia.	R. Oak	1909	1,590	1,160	27	18.9	25.0
Missouri	Princeton, Mo.	R. Oak	1909	399	249	38	17.8	22.9
Neb. Colo.	Fairbury, Neb.	R. Oak	1909	321	284	11	19.6	**
	Goodland, Kans.	R. Oak	1909	1,118	1,076	3	19.8	**
Kans.	Topeka, Kans.	R. Oak	1909	921	508	44	18.5	21.9
	Total	R. Oak	1909	8,105	5,895	27	18.8	25.0
Illinois	Tiskilwa, Ill.	Gum	1909	58	35	39	18.3	22.9
Iowa	Altoona, Ia.	Gum	1909	63	59	4	19.7	**
Missouri	E. Des Moines, Ia.	Gum	1909	596	265	55	17.5	20.6
C. R. Minn.	Ely, Ia.	Gum	1909	126	69	45	17.9	21.9
Dakota	West Bend, Ia.	Gum	1909	539	444	17	19.1	**
	Total	Gum	1909	1,382	872	37	18.4	23.2
Missouri	E. Des Moines, Ia.	Pine	1909	364	186	49	18.4	21.5
C. R. Minn.	Ely, Ia.	Pine	1909	214	164	23	18.8	25.9
Neb. Colo.	Goodland, Kans.	Pine	1909	136	132	3	19.6	**
El. P. Am.	Dalhart, Tex.	Pine	1909	165	137	17	19.2	**
	Total	Pine	1909	879	619	29	18.8	24.6
Illinois	Tiskilwa, Ill.	R. Oak	1910	2,860	2,011	29	18.0	23.5
Iowa	Altoona, Ia.	R. Oak	1910	583	546	6	18.6	**
C. R. Minn.	Ely, Ia.	R. Oak	1910	2,343	1,866	20	17.9	25.6
	Clarksville, Ia.	R. Oak	1910	1,473	1,198	18	18.4	**
Missouri	Princeton, Mo.	R. Oak	1910	997	605	39	16.9	21.8
Neb. Colo.	Fairbury, Neb.	R. Oak	1910	1,721	1,524	11	18.6	**
St. L. KCT.	Eldon, Mo.	R. Oak	1910	4,129	3,005	27	18.1	23.7
Kans.	Topeka, Kans.	R. Oak	1910	437	229	47	17.5	20.6
	Total	R. Oak	1910	14,543	10,984	24	18.1	24.6
Missouri	E. Des Moines, Ia.	Gum	1910	299	131	56	16.6	19.5
C. R. Minn.	Ely, Ia.	Gum	1910	159	99	38	17.0	21.8
Dakota	West Bend, Ia.	Gum	1910	279	267	4	18.4	**
	Total	Gum	1910	737	497	31	17.4	22.9

* Estimated average life based on Forest Products Laboratory Curve.
** Estimated average life cannot be determined by curve when renewals to date are less than twenty per cent.

ROCK ISLAND LINES

Special Report of Ties in Test Sections—Fall Inspection 1929
Creosoted Ties "Lowry" Process (1907 to 1912 Inclusive)

Divisions	Location	Kind of Ties	Year	Number of Ties: Inserted	Number of Ties: Remaining in Track	Per Cent Removed	Av. Life Yrs. End 1929	Estimated Av. Life Yrs.*
Missouri	E. Des Moines, Ia.	Pine	1910	155	116	25	18.0	24.3
C. R. Minn.	Ely, Ia.	Pine	1910	108	78	28	17.6	23.7
Dakota	West Bend, Ia.	Pine	1910	57	54	5	18.3	**
Neb. Colo.	Fairbury, Neb.	Pine	1910	231	219	5	18.8	**
	Goodland, Kans.	Pine	1910	727	707	3	18.9	**
Kansas	Topeka, Kans.	Pine	1910	256	152	40	17.5	21.6
	Total	Pine	1910	1,534	1,326	13	18.5	**
Illinois	Tiskilwa, Ill.	R. Oak	1911	1,099	835	24	17.2	23.3
Iowa	Altoona, Ia.	R. Oak	1911	763	726	5	17.7	**
Missouri	Princeton, Mo.	R. Oak	1911	1,803	1,436	20	17.3	24.3
C. R. Minn.	Ely, Ia.	R. Oak	1911	2,256	1,999	11	17.5	**
Dakota	West Bend, Ia.	R. Oak	1911	89	79	11	17.6	**
Neb. Colo.	Fairbury, Neb.	R. Oak	1911	51	47	7	17.7	**
	Goodland, Kans.	R. Oak	1911	105	105	0	18.0	**
	Total	R. Oak	1911	6,166	5,227	15	17.4	**
Iowa	Altoona, Ia.	Gum	1911	299	270	9	17.7	**
Missouri	Princeton, Mo.	Gum	1911	707	523	26	16.3	22.7
C. R. Minn.	Ely, Ia.	Gum	1911	344	272	21	17.4	24.0
Neb. Colo.	Fairbury, Neb.	Gum	1911	67	33	50	15.6	19.1
	Total	Gum	1911	1.417	1,098	22	16.8	23.6
Illinois	Tiskilwa, Ill.	Pine	1911	67	42	37	15.8	20.9
Missouri	E. Des Moines, Ia.	Pine	1911	56	39	30	16.8	21.9
C. R. Minn.	Clarksville, Ia.	Pine	1911	1,013	951	6	17.8	**
Dakota	West Bend, Ia.	Pine	1911	812	767	5	17.7	**
Neb. Colo.	Fairbury, Neb.	Pine	1911	1,496	1,391	6	17.6	**
	Goodland, Kans.	Pine	1911	1,603	1,508	6	17.8	**
Kansas	Topeka, Kans.	Pine	1911	146	130	11	16.8	**
	Total	Pine	1911	5,193	4,828	10	17.7	**
Illinois	Tiskilwa, Ill.	R. Oak	1912	194	150	22	16.0	22.3
Iowa	Altoona, Ia.	R. Oak	1912	750	663	11	15.9	**
Missouri	Princeton, Mo.	R. Oak	1912	331	193	41	13.6	19.3
	E. Des Moines, Ia.	R. Oak	1912	5.449	5,283	8	16.8	**
C. R. Minn.	Ely, Ia.	R. Oak	1912	465	436	6	16.8	**
Neb. Colo.	Goodland, Kans.	R. Oak	1912	83	82		16.9	**
St. LKCT.	Eldon, Mo.	R. Oak	1912	2,416	2,235	8	17.6	**
	Total	R. Oak	1912	9,688	9,042	6	16.6	**
Illinois	Tiskilwa, Ill.	Gum	1912	676	591	13	16.5	**
Missouri	E. Des Moines, Ia.	Gum	1912	1,253	1,038	17	16.8	**
C. R. Minn.	Ely, Ia.	Gum	1912	1.232	1,020	17	16.3	**
	Total	Gum	1912	3.161	2,649	16	16.4	**
C. R. Minn.	Ely, Ia.	Pine	1912	345	308	11	16.7	**
	Clarksville, Ia.	Pine	1912	1,037	979	5	16.8	**
Dakota	West Bend, Ia.	Pine	1912	711	686	3	16.8	**
Neb. Colo.	Faribury, Neb.	Pine	1912	1,370	1,293	6	16.8	**
	Goodland, Kans.	Pine	1912	536	513	6	16.8	**
Kansas	Topeka, Kans.	Pine	1912	258	138	46	15.2	18.4
Dalhart	Dalhart, Tex.	Pine	1912	278	253	9	16.6	**
	Total	Pine	1912	4,535	4,170	8	16.7	**

* Estimated average life based on Forest Products Laboratory Cusve.
** Estimated average life cannot be determined by curve when renewals to date are less than twenty per cent.

Appendix B

(2) PILING USED FOR MARINE CONSTRUCTION

Wm. G. Atwood, Chairman, Sub-Committee; C. C. Cook, H. R. Condon, E. A. Craft, Andrew Gibson, L. H. Harper, H. E. Horrocks, W. H. Kirkbride, G. C. Stephenson.

The Sub-Committee submits its report on the recent inspections of long time test pieces prepared by the Chemical Warfare Service, some of its own members, and other co-operators. There is also included miscellaneous information and service records received from sources outside the Association and an abstract of the Tenth and Eleventh Interim Reports of the "Sea Action Committee" of the Institution of Civil Engineers of England. This report is submitted as information.

1. Tropical Timber.

ANGELIQUE *(Dicorynia paraënsis, Benth)*
Florida East Coast Ry.
St. Augustine, Fla.—Test piece lost.
Southern Pacific Company
Galveston, Texas—Test piece lost.
Panama Canal
Balboa, C.Z. Submerged Sept. 13, 1923. Wood is comparatively sound, but has been attacked by Limnoria and shows some teredo holes.

MANBARKLAK *(Lecythis ollaria, L)*
Florida East Coast Ry.
Key West, Florida. Submerged August 5, 1923. The limnoria attack previously reported, has continued. The bottom of the test piece has been eroded to a depth of about 3 in. and the sides about 1¾ in.
Southern Pacific Company
Galveston, Texas—Test piece lost.
Panama Canal
Balboa, C.Z. Submerged Sept. 13, 1923. There appears to be more teredo holes than were found at the inspection of last year, but the wood is still quite sound.

GREENHEART *(Nectanda rodieoi, Schomb)*
Panama Canal
Balboa, C.Z. Submerged Sept. 13, 1923. More teredo holes in evidence than at 1929 inspection but wood still fairly sound.

TURPENTINE WOOD *(Syncarpia laurifolia, Tenore)*
U.S. District Engineer, Charleston, S.C.
Submerged at Castle Pinckney, S.C., June 24, 1926. Teredo attack on the surface but wood sound otherwise.
Naval Air Station, Pensacola, Fla.
Submerged July 19, 1924. Teredo attack on the surface and some shallow holes probably made by martesia though none of these animals were found. Heartwood sound.
Panama Canal
Balboa, C.Z. Submerged Aug. 19, 1929. One specimen shows very light attack while the other has many more teredo holes in both sides and end. Decidedly heavier attack than was found in 1929.

PANAMA CANAL

Through the courtesy of Col. Harry Burgess, Governor of the Panama Canal Zone we are able to present the following report on the tests being made of various tropical timbers which have been reported to be resistant to marine borer attack.

Practically every sample had considerable marine growth, consisting of barnacles, worm-tubes, eggs of mollusks, bryozoans, and the bulk consisting of the following mollusks: Crepidula squama lessoni, C. aculsata, C. onyx, Crucibulum spinosum, Anomia peruviana and some Ostreidas.

It is remarkable that none of the samples were without teredos, not even those that a year ago were in healthy condition. As is to be expected, some were less attacked than others.

One sample, Kolaka (rack 19) was not located and it would appear that it broke off from the chain. If possible it should be found and returned to the test.

All of the treated timbers, Ac-Zol, Montan Wax and creosoted apitong, were badly infested. One of the Ac-zol was closed out and the other, although heavily infested, was returned to the test. All of the Montan Wax treated and the creosoted apitong were closed out. In addition, Huon Pine and Mongon were closed out. I have no record as to amount of creosote in the apitong.

In addition to Neobankia zeteki, another species of Teredo was found which I will have to study and report upon later. It does not appear to be any of the known species of this area and may be new. Its pallets are unusually large.

Anoura (Dutch Guiana, size 8" x 8" x 24", rack No. 2, submerged Sept. 13, 1923). There are more teredo holes than last year, more work by both teredo and gribble. Some of the teredo holes are ¼ inch diameter. It is worse than the greenheart.

Foengo (Dutch Guiana, size 8" x 8" x 24", rack No. 4, submerged Sept. 13, 1923). There are many more teredo holes on all sides and bottom than were seen last year, but the wood is quite sound.

Spence Hordoe (Dutch Guiana, size 8" x 8" x 24", rack No. 5, submerged Sept. 13, 1923). Not much marine growth except many barnacles on bottom. Several large teredo burrows, some ¼ inch diameter, on all sides and end.

Ingi Barki (Dutch Guiana, size 6½" x 7" x 24", rack No. 6, submerged Sept. 13, 1923). The end has many barnacles also many teredo holes. There are many more teredos on all sides than a year ago, pallets frequently seen, but the wood is still quite sound.

Malabayabas (Philippine Islands, size 12" x 12" x 13", rack No. 9, submerged Sept. 13, 1923). The wood is sound, the end and sides have much marine growth and many teredo holes, but these are so far small.

Apitong Creosoted (Philippine Islands, size 8" x 6" x 3", rack No. 10, submerged Sept. 13, 1923). This is a small sample, and I do not know whether it was pressure treated or brushed, and if by pressure whether considerable retention of creosote took place. Certainly the gribble and teredo found the creosote and the wood suitable, for the sample was completely riddled by teredo and the surfaces eaten by gribble. Some of the teredo were ¼" and ⅜" diameter. I found also a few bivalves, Martesia sp. Will report on the specific name later on. This sample was CLOSED, that is, removed from the tests.

Kajol Lara (Celebes, size 6½" x 6½" x 30", rack No. 11, submerged Oct. 26, 1925). The inside appears to be sound. Many small teredo holes on all sides, more than last year. Gribble negligible. Much marine growth on end.

KAJOL MALAS (Sumatra, size 6" x 6" x 30", rack No. 12, submerged Oct. 26, 1925). Inside appears to be sound but there are more teredos than last year and some gribble. Much marine growth at ground eng.

KOLAKA (Celebes, size 6½" x 6½" x 30", rack No. 19, submerged Oct. 26, 1925). Broken off from chain, do not know when because the chain had nothing attached to it.

YELLOW PINE—MONTAN WAX TREATED (U.S.A., size 5 samples each 1¾" x 4" x 16", rack No. 20, submerged Oct. 19, 1927). 5 samples treated as follows:

A-1 containing 93 per cent by weight of 50 per cent Montan wax and 50 per cent creosote.
A-5 containing 80 per cent by weight of 60 per cent Montan wax and 40 per cent creosote.
A-7 containing 30 per cent by weight of 40 per cent Montan wax and 60 per cent creosote.
A-8 containing 62½ per cent by weight of Montan wax.
A-9 an untreated control piece.

A-1, A-5, A-7, A-8 all had much marine growth. In A-1 were only two teredos and the wood was darker than that of the other three. This sample was the best of the four. A-5 had six teredos, ¼ inch diameter, and a Martesia sp., A-7 had many teredos, ¼ inch diameter, and several Martesia sp., A-8 was well riddled with teredos, and had several Martesia sp.

A-9 showed much damage from gribble and was riddled by teredos. It also had one Martesia sp.

All samples closed out.

ALCORNOQUE (Panama, size 6" x 6" x 53", rack No. 14, submerged Nov. 22, 1927). Much marine growth on sides and end, few small teredo holes on sides and end. Wood very sound and appears to be all heartwood.

RED SATINWAY (Queensland, size 6" x 6" x 24", rack No. 21, submerged April 19, 1929). The end has many teredos some ¼ inch diameter, sides have very many teredo holes, some over ¼ inch diameter, and apparently going in deep. I did not cut into the wood.

BRUSH BOX (New South Wales, size 6" x 6" x 24", rack No. 22, submerged April 19, 1929). It has several teredo holes on sides and end, however not bad as yet. No gribble work.

YELLOW PINE—AC-ZOL TREATED (U.S.A., size 6" diam. x 30" long, rack No. 23, submerged April 19, 1929). Considerable surface destruction by gribble and very many teredo holes, ⅛ inches diam. Inside is evidently well riddled as can be told by tapping the wood with a hammer. No doubt a year from now it will be closed out.

YELLOW PINE—AC-ZOL TREATED (U.S.A., size 6" dia. x 30" long, rack No. 24, submerged April 19, 1929). As above, but worse. Much marine growth as well. Gribble very bad. When hit with hammer, sound was "spongy." Was closed.

HUON PINE (Tasmania, size 8" x 8" x 24", rack No. 28, submerged April 14, 1929). I counted fully 80 teredo holes on one side, pallets sticking out, or being moved in and out. Completely honeycombed, especially large teredos, ½ inch to ⅞ inch diameter tubes, both species. Many Martesia were present as well. See photos showing face view and cross sections. Closed (Fig. 1).

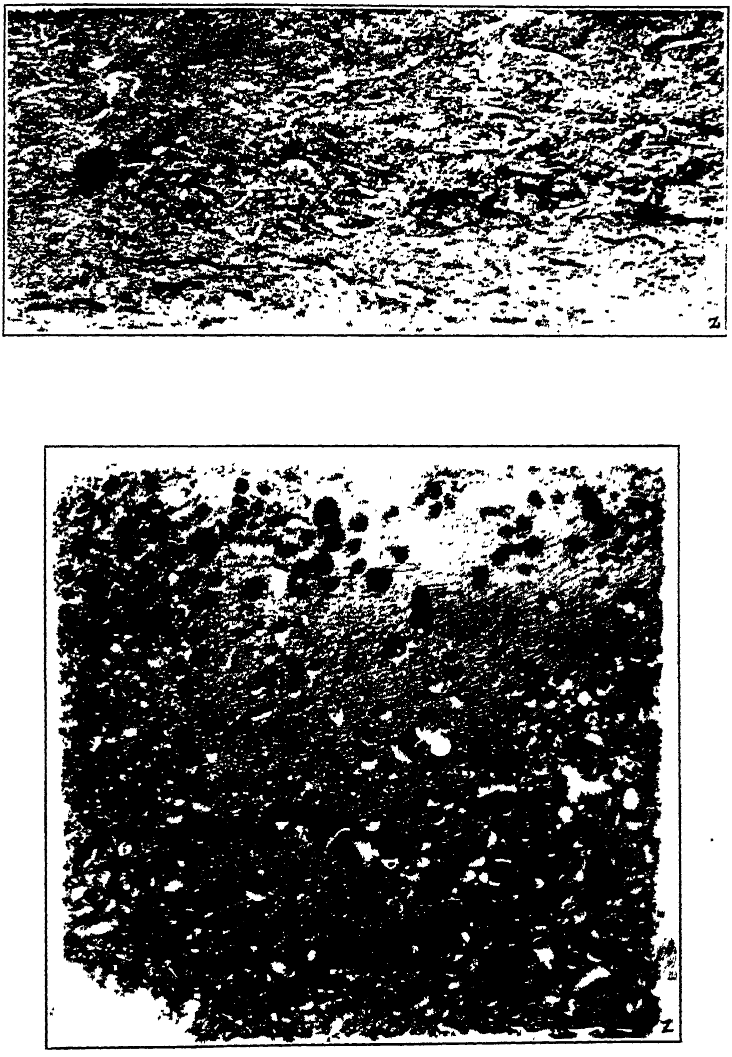


FIG. 1—HUON PINE (RACK 28) SHOWING SURFACE DESTRUCTION, AND A CROSS-SECTION DEPICTING DAMAGE DONE BY TEREDOS IN ONE YEAR. SIZE 8" x 8" x 24".

ALAZANO (Panama, size 6" x 6" x 30", rack No. 8, submerged Oct. 17, 1929). This is Calycophyllum candidissimum (Vahl.) D.C. The wood is still very sound but I found many fine teredo holes on all sides, some ¼ inch diameter, and it appears they will like this wood, although it is reputed to be teredo resistant.

MONGON WOOD (Panama, size 5" x 5" x 28", rack No. 29, submerged Dec. 27, 1929). This is red mangrove, Rhizophora mangle L., from the San Blas region of Panama and reputed to be teredo resistant. On all sides and the end I saw innumerable pallets sticking out, or moving in and out, at least a hundred on one face, and when cut open the wood was completely honeycombed, some specimens with tubes ⅞ inch diameter, both species. Closed.

NICARGUAN PITCH PINE (Nicaragua, size 8" x 8" x 30", rack No. 13, submerged March 12, 1930). I do not know specific name as yet. Although there is much marine growth on sides and end, I saw no evidence as yet of teredo or gribble.

It will be noted that four new test pieces have been added since the last inspection, namely, Huon Pine, Alazano, Mongon Wood, and Nicaraguan Creosote Pitch Pine. A specimen of treated Amarillo Wood and one of TRI-treated Yellow Pine will be received shortly and placed on test.

In case the Kolaka test piece is recovered, information concerning its condition will be forwarded to you.

In Mr. Zetek's report sent you last year, mention is made of three Turpentine Wood samples. This is incorrect. There are only two samples, in racks 25 and 27.

Also in last year's report it was recommended by Mr. Zetek that the following specimens be closed out: Almendro (rack No. 8) from Panama, Alcornoque (rack No. 13) from Panama, and Fir (racks Nos. 15, 16, 17, 18) from U.S.A. with copper screening. This was done and the following supplementary report was made by Mr. Zetek on Sept. 21, 1929:

> Supplementing my report on the examination of the samples of wood in the teredo test rack at Balboa, made by me on August 14, 1929:
>
> I received the following at my laboratory, which I dissected:
> No. 8—Almendro
> No. 14—Alcornoque
> Nos. 16, 18—Fir covered with 16 mesh Cu screening.
>
> The Almendro showed thorough infestation, shipworms alive and in large numbers. When left standing for awhile, the pallets were found to be projecting out from the small exterior openings, none of the teredos were very large.
>
> The Alcornoque was much more infested than when examined in 1928, but very few live teredos were found. All others were dead and putrid and much mud was in the burrows. This was one of the samples that were lost in the mud at Miraflores and later recovered Some of the burrows were ¾ inch in diameter.
>
> In my report of August 14, 1929, I state I knew nothing of the other alcornoque (No. 14) but this is not so as I did report on it August 31, 1928.
>
> In the case of No. 16, fir covered with 16 mesh copper screening, I found that the screening was badly torn and in places completely gone. Teredos were very plentiful in this sample, some of the burrows ¼ inch in diameter and extending well into the center. All were alive.

In the case of No. 18, the screening was almost intact and the number of teredos was very small. Wherever the screening was damaged, as along some of the edges, teredos were found. I also found a few where the screening was good. It does not appear to be a practical measure even if the screening does tend to inhibit the development of teredos.

No. 15 and No. 17 were those that had broken from the chain and not recovered. I do not care for them, hence there is no need to try and locate them.

The most plentiful teredo by far was *Neobankia zeteki*, but I also found two other kinds, the pallets of which are quite distinct and do not resemble those of any species known to me through literature I have on hand. There was also one specimen which I am tentatively referring to *N. miraflora*."

CHEMICAL WARFARE SERVICE SPECIMENS

These test pieces were treated by the Chemical Warfare Service in their own experimental treating plant at the Edgewood Arsenal as follows:

No. 1—A 1 per cent solution of ammoniacal copper carbonate.
No. 2—1 per cent diphenylamine chlorarsene in creosote.
No. 3—.75 per cent diphenylamine chlorarsene and .5 per cent phenyldichorarsene in fuel oil.

Reports of inspection of test pieces are as follows:

New York, New Haven and Hartford R.R.

Warren, R.I. Submerged May, 1925. Test pieces reported lost in 1929 have been found. The untreated control piece showed a light attack but none of the treated specimens were attacked.

U.S. District Engineer, Charleston, S.C.

Two duplicate sets of specimens were submerged at Castle Pinckney, June, 1925.

One No. 1 specimen was attacked by Limnoria but the other was in good condition and the same condition exists with the No. 2 specimens (Fig. 2).

One No. 3 specimen has been lightly and the other heavily attacked by Limnoria and teredo.

Florida East Coast Ry.

Key West, Florida. Submerged Sept. 21, 1925. All test pieces show some attack though none are badly damaged. The untreated controls were entirely destroyed.

U.S. Naval Air Station, Pensacola, Fla. Submerged June 5, 1925. One No. 1 piece destroyed by Limnoria and teredo and the other heavily attacked. There is no attack apparent on either of the No. 2 pieces. The No. 3 pieces are attacked by teredo, one of them fairly heavily, and the other not so heavily but little or no Limnoria attack is evident.

Bureau of Lighthouses

San Juan, P.R. Submerged July 1, 1925. One No. 1 piece is heavily attacked by Limnoria and the other not so badly. One No. 2 piece has been lost and the other shows no attack. Both No. 3 pieces were so heavily attacked in 1929 that they were eliminated.

U.S. Navy

Coco Solo, C.Z.

A. Submerged July 23, 1925, in front of Quarters "E," Submarine Base. Inspection report not yet received.

B. Submerged August 11, 1925, at boat house building No. 24. Inspection report not yet received.

Southern Pacific Company

San Francisco Bay, Oakland Pier. Submerged July 21, 1925. No attack on treated pieces though untreated control was heavily attacked by Limnoria and lightly by teredo.

Port Costa. Submerged July 22, 1925. Untreated control piece destroyed by teredo but no attack evident on any of the treated pieces.

Puget Sound Navy Yard

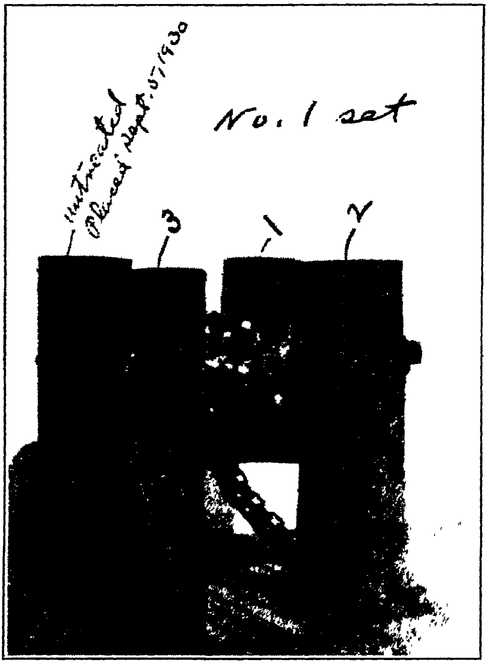


Fig. 2—Set of Chemical Warfare Service Specimens Submerged at Castle Pinckney June, 1925.

Bremerton, Wash. Pier 4. Submerged Oct. 14, 1925. Untreated control destroyed by Bankia. The No. 1 piece was not attacked and the Nos. 2 and 3 showed light Limnoria attack.

Pier 8. Submerged Nov. 3, 1925. No attack on treated pieces though untreated control piece was destroyed by Bankia.

U.S. Navy Yard

Pearl Harbor, H.I. Coaling Pier. Submerged Aug. 17, 1925. Report of 1929 inspection was received too late for publication last year. It showed that the No. 1 specimen was heavily attacked by teredo and the No. 3 specimen by Limnoria but the No. 2 specimen was not attacked. (Fig. 3).

Inspection on Sept. 24, 1930 showed that the No. 1 piece had been about 50 per cent destroyed by teredo, the No. 2 piece showed no sign of attack, and the No. 3 piece was about 40 per cent destroyed by Limnoria and Teredo. The untreated control piece was totally destroyed.

CHEMICAL WARFARE SERVICE

The Chemical Warfare Service have continued the laboratory and service tests initiated in 1922. The service tests are being carried on with the cooperation of the Bureau of Fisheries at Beaufort, N.C. By the courtesy of Maj. Gen. H. L. Gilchrist, Chief of the Chemical Warfare Service, we are able to present the following report on these experiments. The report was submitted by the Commanding Officer of the Edgewood Arsenal.

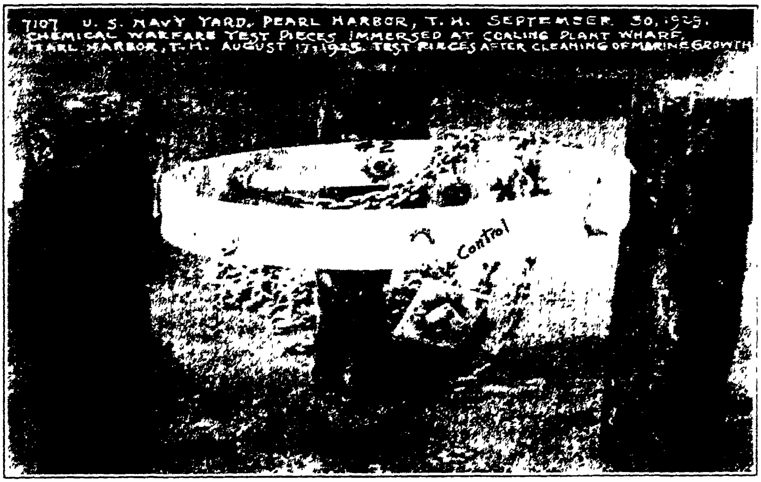


FIG. 3—CHEMICAL WARFARE SERVICE TEST RACK. NAVAL OPERATING BASE, PEARL HARBOR, H. I.

REPORT ON TESTS AT BEAUFORT, N.C.—MARINE PILING INVESTIGATION

The Chemical Warfare Service has 563 impregnated boards installed on test against marine wood boring organisms in the terrapin pens at U.S. Bureau of Fisheries, Pivers Island, Beaufort, N.C.

The impregnated pieces are 30″ x ⅞″, and in a number of cases are nailed to stringers that are already infested with limnoria and shipworm. This is a more severe test than piling is ordinarily subjected to, and serves as an accelerated service test of the toxics used in impregnating the boards. Due to the fact that all available space has been utilized in the pens, 108 test

pieces 4″ x 8″ x ⅞″ are installed in the fish ponds. Alternate test pieces have bait pieces attached and every eighth board is a control. Unimpregnated boards are used as controls and serve as a measure of the distribution and intensity of the attack by borers. These boards need to be replaced by new ones each year.

The following vehicles, alone or in combination, were used to carry the toxics: Creosote, naphthalene, Montan wax and oil. A majority of the toxics used, with the above impregnants, were Chemical Warfare Agents.

The boards impregnated with oil, with the exception of those containing arsenic trichloride, show a greater percentage of attack than boards impregnated with any other vehicle.

The Chemical Warfare agents having most promise for a two year period are: Diphenylamine chlorarsine, methylarsenious oxide, phenylarsenious oxide and bromacetophenone. While boards impregnated with vehicles containing arsenic trichloride showed practically no attack, yet all these boards were badly charred, were easily split and broken, and had attacked the nails holding the boards in place. The toxics have highly vesicant properties, as mustard gas and lewisite, have not been tested against borers in impregnated wood.

One hundred eight (108) test pieces were installed in April, 1930, but no inspection has been made on these pieces to date.

In the following table the boards of the various sets are grouped together, regardless of which pen they were installed in. Under "Severity of Attack" is given a figure obtained by rating the attack as follows:

0—None
1—Slight
2—Moderate
3—Considerable
4—Heavy

Then the figures for attack on any given set are added, and if necessary calculated to a basis of 10 boards per set.

TABLE

Set No.	Vehicle lbs.				Toxic	No. Boards Installed	No. Boards Attacked	Severity of Attack	Date Installed
14	30 Creosote	30 Fuel Oil	100 C10H8		6 PDCB	5	3	10.0	5–16–28
15	30 Creosote	30 Fuel Oil	100 C10H8	25 Montan Wax		6	3	8.6	5–16–28
1	150 Creosote	----------	----------	----------	----------	5	0	0	5–16–28
2	54 Creosote	90 C10H8	----------	----------	----------	6	0	0	5–16–28
3	60 Creosote	---------- C10H8	----------	----------	3 DM	6	2	11.7	5–16–28
4	153 Creosote	----------	----------	----------	3 DM	4	0	0	5–16–28
5	----------	150 Fuel Oil	----------	----------	2½ DA	6	2	5.0	5–16–28
6	----------	60 Fuel Oil	100 C10H8	----------	2½ DA	6	4	16.7	5–16–28
6	30 Creosote	30 Fuel Oil	100 C10H8	----------	1½ DA ½ DM	6	1	1.7	5–16–28
8	90 Creosote	----------	----------	50 Montan Wax	1½ DM	6	0	0	5–16–28
9	70 Creosote	70 Fuel Oil	----------	----------	DA DM 7 Cu. Res.	6	1	3.3	5–16–28
10	150 Creosote	----------	----------	----------	7 Cu. Res.	10	3	3.0	7–12–28
11	60 Creosote	----------	90 C10H8	----------	7 Cu. Res.	10	1	3.0	7–12–28
12	90 Creosote	----------	30 C10H8	30 Montan Wax	1 DM	10	0	0	7–12 28
13	150 Creosote	----------	----------	----------	----------	9	1	1.0	7–12 28
14**	60 Creosote	----------	90 C10H8	----------	----------	10	3	4.0	7–12 28
15**	60 Creosote	----------	90 C10H8	----------	8 beta Naphthol	10	4	6.0	7–12 28
16	60 Creosote	----------	90 C10H8	15–2 DM	2 DM–6beta naphthol	10	4	10.0	7–12 28
17	30 Creosote	30 Fuel Oil	90 C10H8	B-7	DA DM	9	3	5.5	7–12 28
18	----------	150 Fuel Oil	----------	----------	2 DA	10	4	6.0	7–12 28
19	----------	150 Fuel Oil	----------	----------	8 PDCB	10	2	6.0	7–12 28
20	----------	60 Fuel Oil	90 C10H8	----------	7 PDCB	10	6	12.0	7–12 28
21	----------	60 Fuel Oil	90 C10H8	19 & 20 -2 DA	2 DA 7 PDCB	9	2	2 2	7–122–8
22	80 Creosote	40 Fuel Oil	38 Montan Wax		5 Cu. Res. ½ DA ½ DM	10	4	4.0	11–18–28
23	90 Fuel Oil	62 Montan Wax	+90-B-18		1¼ DA	10	4	8.0	11–18–28

TABLE—Continued

Set No.	Vehicle lbs.				Toxic	No. Boards Installed	No. Boards Attacked	Severity of Attack	Date Installed
24	80 Fuel Oil	35 C10H8	25 Montan Wax	3 Chloracetophenone	------------	10	3	4.0	11-18-28
25	150 Creosote	----------	----------	----------	------------	10	1	1.0	11-18-28
26	150 Creosote	----------	----------	----------	3 AsC13	10	0	0	11-18-28
27	60 Creosote	90 C10H8	----------	----------	3 As C13	10	0	0	11-18-28
28	60 Creosote	90 C10H8	----------	----------	3 AsC13 3 diphenylamine	10	1	1.0	11-18-28
29	150 Creosote	----------	----------	----------	3 AsC13 3 diphenylamine	10	0	0	11-18-28
30	150 Oil A Texas Co.	----------	----------	----------	3 AsC13	10	0	0	11-18-28
31	60 Oil A Texas Co.	90 C10H8	----------	----------	3 AsC13	10	0	0	11-18-28
32	60 Oil A	90 C10H8	----------	----------	3 AsC13 2 DA	10	0	0	11-18-28
33	Oil B150	Texas Co.	----------	----------	3 AsC13	10	0	0	11-18-28
34	60 Oil B TC	90 C10H8	----------	----------	3 AsC13	10	0	0	11-18-28
35	60 Oil B TC	----------	90 C10H8	----------	2 DA 3 AsC13	10	2	2.0	11-18-28
36	150 Creosote	----------	----------	----------	------------	10	0	0	11-18-28
37	150 Creosote	----------	----------	----------	7 Cd Cl 2	10	0	0	11-18-28
38	60 Creosote	90 C10H8	----------	----------	7½CdC12	10	0	0	11-18-28
39	60 Creosote	90 C10H8	----------	----------	3 CH3As0	10	0	0	11-18-28
40	60 Creosote	70 C10H8	20 Anthracene	----------	3 Ch3As0	10	0	0	11-18-28
41—	60 Creosote	80 C10H8	20 Anthracene	----------	------------	10	1	1.0	11-18-28
45	60 Creosote	90 C10H8	----------	----------	3 Bromacetophenone	6	0	0	5-14-29
46	60 Creosote	90 C10H8	----------	----------	7½ DNP	6	0	0	5-14-29
47	60 Creosote	90 C10H8	----------	----------	1¼ C6H5 As0	6	0	0	5-14-29
48	60 S. O. Light oil	90 C10H8	----------	----------	1.5 DM	6	0	0	5-14-29
49	60 SO Heavy	90 C10H8	----------	----------	1.5 DM	6	0	0	5-14-29
50	150 SO Light oil	----------	----------	----------	1.5 DM	6	3	8.3	5-14-29
51	150 SO Heavy	----------	----------	----------	1.5 DM	6	4	11.7	5-14-29

LEGENDS OF ABBREVIATIONS

C10H8—Napthalene	AsC13—Arsenic trichloride
CH3AsO—Methylarsenious oxide	CdC12—Cadmium chloride
PDCB—Paradichlorbenzol	DNP—Dinitrophenol
DM—Diphenylaminechlorarsine	C6H5AsO—Phenylarsenious oxide
DA—Diphenylchlorarsine	SO—Standard Oil Company
Cu.Res.—Copper resinate	TC—Texas Oil Company

SAN FRANCISCO BAY TESTS

These tests were initiated by the Marine Piling Committee of the National Research Council and some test series have been added since by this Sub-Committee. For a detailed description of the creosote oils used, see pages 144-148, "Marine Structures, Their Deterioration and Preservation," by Atwood and Johnson, 1924.

Report of Inspection September 19, 1930, of
Specimens furnished through Herman von Schrenk and Col.
Atwood, and installed in San Francisco Bay

(P=Pine F=Fir)

Barrett Manufacturing Company Material

Placed Station B, Pier 7, San Francisco, January, 1923, moved to Biological Station, Oakland Pier, c/o S.P. Co., December, 1925. No attack except slightly Limnoria.

Gate No.	*Specimen No.*	*Treatment*	*Condition Sept. 19, 1930*
B-4	P.1	Coke oven original oil	P. 1 intact
	2	ditto solids removed	P 2, 3 and 4 slightly eroded by Limnoria on ends; sides slightly attacked near ends. No apparent increase since last year.
	3	ditto acids removed	
	4	ditto bases removed	
B-5	P5	Coke, minus residue above 360 deg. C.	All slightly eroded by Limnoria on ends. P5 also on sides next to end. P8 slightly worse. No apparent change since last year.
	6	Coke, minus fraction 239-270 deg. C.	
	7	Coke, minus fraction up to 230 deg. C.	
	8	Coke, minus fraction 270-360 deg. C.	
B-6	P 9	Vertical retort original oil	Light general Limnoria attack on ends and sides. No apparent change since last year.
	10	ditto minus solids	
	11	ditto minus acids	
	12	ditto minus bases	
B-7	P13	ditto, minus residue above 360 deg. C.)	
	14	ditto, minus fraction 230-270 deg. C.)	A few limnoria burrows on ends.
	15	ditto, minus fraction up to 230 deg. C.	No attack.
	16	ditto, minus fraction 270-360 deg. C.	No attack.

Gate No.	*Specimen No.*	*Treatment*	*Condition Sept. 19, 1930*
B-8	F 1	Coke oven oils duplicating B 4 in identical order.	All slightly eroded on ends. On sides attack confined to line across specimens where gate had rubbed against a submerged brace. No apparent change since last year.
B-9	F 5 6 7 8	Coke oven oils duplicating B-5 in identical order.	All slightly eroded on ends. Only traces on sides. No apparent change since last year.
B-10	F 9 10 11 12	Vertical retort oils duplicating B-6 in identical order.	All show slight erosion on ends and sides near ends. One small dead Bankia found; burrow exposed by wave erosion.
B-11	F13 14 15 16	Vertical retort oils duplicating B-7 in identical order.	Considerable Limnoria attack on 13 and 16. Light attack on 14 and 15. One small teredo hole in No. 13 has been exposed by Limnoria. Very little change since last year.

1930 REPORT ON TEST PILES

For original description of these piles see:

1. Am. Wood Preservers Association 1920. Pages 148-178.
2. Marine Structures, Their Deterioration and Preservation, Atwood and Johnson, Pages 109-116.

See previous A.R.E.A. reports:

Vol. 23, 1922—Page 959
Vol. 27, 1926—Page 989
Vol. 28, 1927—Page 1155
Vol. 29, 1928—Page 723
Vol. 30, 1929—Page 676
Vol. 31, 1930—Page 695

The following tables, 1-A to 1-D give the 1930 condition of four sets of test piles driven in 1919 and 1920 at Seattle, Tiburon in San Francisco Bay, San Pedro and San Diego. Each set originally consisted of seven piles, including the following:

3—Old creosoted fir piles originally driven in 1890 Table 1-A.
1—Old creosoted fir pile originally driven in 1901 Table 1-B.
2—New freshly creosoted fir piles 1-C.
1—New untreated fir pile 1-D.

The untreated piles were destroyed in three or four years as shown in Table 1-D, leaving six piles in each set.

The set at San Diego was exposed for test by the A.T. & S.F. Railway Company in their Wharf 63, until this wharf was dismantled in July of 1925. After being repaired they were redriven by the Southern Pacific Company at Long Beach, California, and the test continued.

TEST PILES—TABLE 1-A. Creosoted Fir Piles from Southern Pacific Company Old Long Wharf Dock "A" Oakland. Originally driven in 1890. Pulled in 1919 and Redriven Elsewhere. Exposed to Marine Borer Attack Forty Years to Date.

	Redriven for Test				Inspection
Mark	*Date*	*Railroad*	*Location*	*Remarks*	*Borers*
A-6	1920	N.P. Ry. Co.	Seattle	No attack to date	
A-8	1920	N.P. Ry. Co.	Seattle	This pile free of teredo	
A-32	1920	N.P. Ry. Co.	Seattle	No attack to date	
A-19	1919	NWP. R.R. Co.	Tiburon*	No attack to date	
A-28	1919	NWP. R.R. Co.	Tiburon*	No attack to date	
A-29	1919	NWP. R.R. Co.	Tiburon*	No attack to date	
A-5	1919	SP. Co.	San Pedro	Slight Limnoria erosion in 3 spots; no change since last year.	Limnoria
A-20	1919	SP. Co.	San Pedro	Slight Limnoria erosion; no change since last year	Limnoria
A-34	1919	SP. Co.	San Pedro	2 holes 3" deep by Limnoria—no change since last year.	Limnoria
A-2	1920	AT. & SF. Ry.	San Diego	Pulled 1925.	
A-2	1925	SP. Co.	Long Beach	Holes attacked by Limnoria repaired in 1925 and attack stopped, no further attack to date.	Limnoria
A-7	1920	AT. & SF. Ry.	San Diego	Pulled 1925.	
A-7	1925	SP. Co.	Long Beach	Holes attacked by Limnoria repaired in 1925 and attack stopped, no further attack to date.	Limnoria
A-33	1930	AT. & SF. Ry.	San Diego	Pulled 1925	Limnoria
A-33	1925	SP. Co.	Long Beach	Holes attacked by Limnoria repaired 1925 and attack stopped. No further attack to date.	

(* San Francisco Bay)

Test Piles Tables 1-B. Creosoted Fir Piles from Southern Pacific Company Old Long Wharf Dock "E," Oakland, Originally Driven in 1901. Pulled in 1919 and Redriven Elsewhere. Exposed to Marine Borer Attack Twenty-Nine Years to Date.

	Redriven for Test				
Mark	*Date*	*Railroad*	*Location*	*Remarks*	*Inspection Borers*
E-46	1920	NP. Ry. Co.	Seattle	This pile free from teredo.	
E-42	1919	NWP. Ry.	Tiburon*	2 holes attacked by Limnoria repaired in 1924; a further slight attack has occurred in 1926 and 1927 but no further attack to date.	Limnoria
E-38	1919	S.P. Co.	San Pedro	Slight attack by Limnoria no change since last year.	Limnoria
(E-50	1920	AT. & SF. RR.	San Diego	Pulled in 1925	
(E-50	1925	S.P. Co.	Long Beach	Old scorings by Limnoria repaired in 1925; slight limnoria attack during 1927. No further change.	Limnoria

(* San Francisco Bay)

Test Piles—Table 1-C. Freshly Creosoted Fir Piles, Exposed to Marine Borer Attack Ten Years to Date.

	Driven for Test				
Mark	*Date*	*Railroad*		*Remarks*	*Inspection Borers*
47	1920	NP. Ry. Co.	Seattle	No attack to date.	
48	1920	NP. Ry. Co.	Seattle	Slight indication of teredo in 3 ft. check near bottom.	Teredo
43	1919	NWP. RR.	Tiburon*	No attack to date.	
44	1919	NWP. RR.	Tiburon*	No attack to date.	
40	1919	SP. Co.	San Pedro	No attack to date.	
41	1919	SP. Co.	San Pedro	No attack to date.	
51	1920	AT. & SF.	San Diego	Pulled 1925.	
51	1925	SP. Co.	Long Beach	Holes attacked by Limnoria repaired 1925 and attack stopped. No further attack to date.	Limnoria
52	1920	AT. & SF. Ry.	San Diego	Pulled 1925.	
52	1925	SP. Co.	Long Beach	Holes attacked by Limnoria repaired in 1925. Attack stopped; no further attack to date.	Limnoria

UNTREATED FIR PILES EXPOSED TO MARINE BORER ATTACK

Driven for Test				1930 Inspection	
Mark	*Date*	*Railroad*	*Location*	*Remarks*	*Borers*
49	1920	NP. Ry. Co.	Seattle	Broken off at mud line 1923.	Limnoria Bankia
45	1919	NWP. RR. Co	Tiburon	Broken off at mud line 1923	Limnoria Bankia Teredo Navalis
39	1920	AT. & SF. Ry.	San Diego	Broken off at mud line 1923.	Limnoria Probably Bankia

(* San Francisco Bay)

AC-ZOL TESTS

A series of specimens about 5 in. diameter, 3 ft. long were treated by the Norfolk Creosoting Company as part of a commercial charge with a 6 per cent solution of Ac-Zol in 1928 and were submerged shortly after. The following inspection reports therefore show the result of about a two years test.

U.S. District Engineer, Charleston, S.C.
One specimen heavily and two more lightly attacked by Limnoria and Teredo.
Panama Canal, Balboa, C.Z.
All specimens heavily attacked by Teredo.
Puget Sound Navy Yard, Bremerton, Wash.
All specimens lightly attacked by Limnoria and Bankia.
U.S. Navy Yard, Pearl Harbor, H.I.
All specimens heavily attacked by Limnoria and Teredo.
U.S. Navy Yard, Cavite, P.I.
Specimens submerged under approach pier No. 4, Machina wharf, Nov. 27, 1929. Both test pieces show a heavy attack principally by Martesia (Fig. 4).

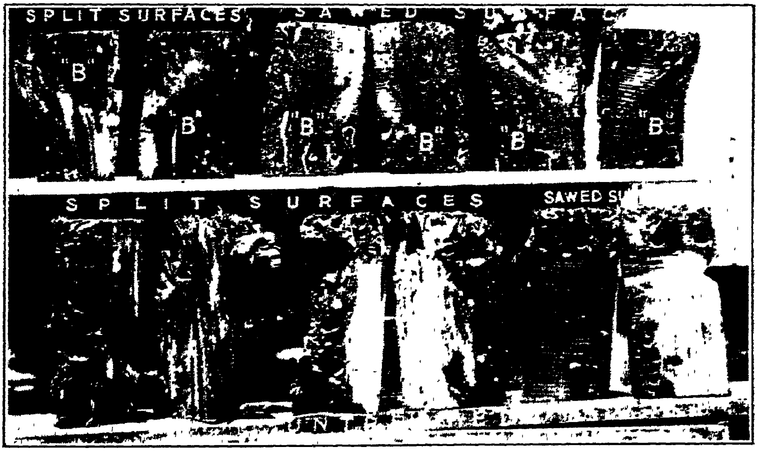


FIG. 4—CAVITE, P. I. UPPER ROW OF SPECIMENS ARE AC-ZOL TREATED—6 PER CENT SOLUTION LOWER ROW UNTREATED FIR.

Standard Fruit and Steamship Company

The Standard Fruit and Steamship Company commenced the construction of a wharf at La Ceiba, Honduras, in 1910 and completed it in 1912. The piles were long leaf pine treated to refusal at the company's plant. An analysis of the creosote used is not available but it is stated to have been a "straight distillate creosote." Renewals were commenced in 1926 and were carried on for the next four years, but there are still a few of the 1910 piles in service at the inshore end of the wharf.

There were 125 Nicaraguan pitch pine piles with a 14 lb. treatment driven in 1926 and 380 "Dense Southern Yellow Pine" piles driven in 1926 and 1927. These latter piles were treated at two plants in the United States, one order of 185 with 20 lb. of A.R.E.A. No. 1 creosote and the other of 195 with an 80/20 per cent creosote coal-tar solution. The 1928 and 1929 replacements (which were Nicaraguan pitch pine) were treated at the Company's plant with 18 lbs. of A.R.E.A. No. 1 Creosote. An 18 lb. treatment is treatment to refusal with this timber.

Practically all the piles driven from 1926 to 1929 show a serious Limnoria attack and will apparently last only a few years longer. This is the shortest service life that has come to the knowledge of the Committee for material which seems to have been well treated. Some of the piles treated in the United States were not inspected, but one of the orders at least is understood to have been treated by one of the most reputable companies in the country.

Copper Resinate Tests

A series of specimens have been treated with copper resinate by a double impregnation process and have been distributed to the various stations where tests are being carried on. These specimens were most of them submerged in the late spring or early summer of 1930. None of them so far reported have been attacked but the period of immersion is too short for this fact to be indicative of the value of this treatment.

"Sea Action Committee"—(England)

The Tenth and Eleventh Interim Reports received since the last report of this committee was written, brings these reports down to the current year.

The Tenth Report dated September, 1929, reports the inspections and continuation of experiments with the arsenical poisons similar to those being tested by the Chemical Warfare Service, U.S.A. The conclusion of the "Sea-Action Committee" is that D M (diphenylamine chlorarsene) is effective but that it is not effective in low concentrations.

A series of experiments were made to determine the relative value of four arsenical compounds using alcohol as the vehicle, because this would quickly evaporate and therefore, protective influence of the vehicle would not influence the test as is the case when creosote is used. The most effective poisons were found to be D M and B D C (a mixture of phenyl arsenious oxide and phenyl arsenious chloride). It was found that 2 per cent of D M was not effective and new series of blocks have been prepared with a 5 per cent solution of each of these arsenicals. These blocks are being tested at Colombo and Singapore.

It is proposed to make a series of tests with standard creosote to which napthalene has been added in order to compare results with the present specification creosote and that used 30 or more years ago.

A progress report is made on the metals being tested for corrosion in and near sea water and the conclusions previously reached are further confirmed after 7 years test. The inspection shows that the best bars exposed to sea air at Auckland, N.Z., Halifax, N.S., and Plymouth are the 13.57 per cent chromium steel, the 3.75 per cent and 36.55 per cent nickel steel and the cast irons.

The report also gives inspection results on tests of painted and tarred plates which show the superiority of horizontal over vertical retort tar for this purpose.

Three hundred reinforced concrete test pieces are being prepared for test. They are to be made with four different cements, some of them with trass replacing either part of the cement or part of the fine aggregate.

The Eleventh Interim Report dated July, 1930, contains later inspection reports but nothing which does not agree with those in the preceeding report. The specimens treated with creosote to which napthalene had been added have been submerged at Kilindini (Kenya Colony) and Mauritius.

Summary

The inspection reports all seem to show a year of great activity of the borers. Many specimens, both untreated tropical woods and treated pieces, previously undamaged now show attack.

Among the tropical timbers, turpentine wood still looks promising but while some other species show very appreciable resistance, none of them appear to be immune from attack.

Attack seems quite general on the No. 1 and No. 3 treatments of the Chemical Warfare Service, while the No. 2 specimens are generally free from attack. It is possible, judging from the results obtained by the English Committee, that the toxic percentage in the No. 3 specimens are too low.

The tests of Ac-Zol treatment show that while the test pieces had a decided resistance to attack that the 6 per cent solution used was not toxic enough to give permanent protection. It apparently had little value against Martesia at Cavite.

The San Francisco specimens treated with various creosotes are not yet heavily attacked and no conclusions can be drawn.

Conclusion

It is recommended that this report be accepted as information and the subject continued.

Appendix C

(3) DESTRUCTION BY TERMITE AND POSSIBLE WAYS OF PREVENTING SAME

Dr. Hermann von Schrenk, Chairman, Sub-Committee; Wm. G. Atwood, C. C. Cook, E. A. Craft, L. H. Harper, F. D. Mattos, C. M. Taylor, C. S. Wiltsee, Jr.

Your Committee has diligently followed the investigations being conducted with reference to termite protection of building construction. Nothing new has developed except the publication of a very interesting report by the Termite Investigations Committee of California*, and it is suggested that those interested write directly to A. A. Brown, Chairman of the Termite Investigations Committee, 215 Market Street, San Francisco, California, for copies of same.

A large number of test pieces of timber treated in various ways are being observed both in this country and the Tropics under the auspices of Dr. T. E. Snyder, Senior Entomologist, United States Bureau of Entomology. It is anticipated that information reference the results of inspections of these test specimens will be made available from year to year as soon as definite results can be communicated.

* Entitled "Termites and Termite Damage," by S. F. Light, Merle Randall and Frank G. White.

Conclusion

It is recommended that this report be accepted as information and the subject be continued.

Appendix D

(4) PRACTICABILITY OF BORING BRIDGE AND SWITCH TIES FOR SPIKES BEFORE TREATMENT

R. S. Hubley, Chairman, Sub-Committee; Wm. G. Atwood, C. S. Burt, H. R. Condon, J. F. Donovan, L. B. Holt, W. H. Kirkbride, W. T. MacCart, T. H. Strate.

For several years now a large number of the railroads who have been treating a majority of their cross ties have been pre-boring the ties for spike holes before treatment, thereby obtaining treated wood around the driven spike and also obtaining a greater amount of the preservative under the rail, where it is mostly needed. The majority of the cross ties being removed from track today, that were not prebored before treatment, will show that the wood had decayed mostly in the vicinity of the spike holes; thereby reducing the holding power of the spike and weakening the track structure. The preboring of the track ties for spike holes before treatment is extending the average life of the ties considerably, by preventing early decay in the vicinity of the spike holes, and the increased life that is now being obtained from the prebored tie reduced to dollars and cents will many times offset the initial cost of the boring. The actual cost of boring ties with the improved adzing, boring and incising machines is a few cents of tie. These machines average

about seven ties a minute. Experiments previously conducted have shown that the holding power of the spikes in prebored holes is greater than when the spike is driven in unbored wood, this being due to the fact that driving the spike in unbored wood shatters the fiber of the wood, while in the prebored hole the wood is less distorted and offers greater resistance to its pulling.

In view of the fact that the preboring of the cross-ties for spikes was found to be an economical proposition, it was thought advisable that probably bridge and switch ties should also be bored before treatment. However, in the preboring of bridge and switch ties due to their various lengths, they could not be bored in the regular tie boring machine but the work would have to be done by hand. This would necessarily increase the cost of the boring considerably. The cost, however, in several of the foreign countries is a secondary consideration and all their switch ties are prebored in a special machine for both the main and turnout rails. They no doubt figure that it is an economical thing to do as well as aiding in timber conservation.

In order to obtain from the various railroads their opinion on this subject, the following questionnaire was submitted to 34 railroads, to which replies were received from 27, as follows:

1. Q.—Are you boring bridge ties for spike holes prior to treatment?
   A.—Six roads replied in the "affirmative" and twenty-one "No."
2. Q.—Do you recommend the boring of bridge ties for spike holes prior to treatment?
   A.—Seventeen replied "yes" and four "no." Several thought that it was the proper thing to do if it was practical and could be done economically. One road stated that "We should do everything we reasonably can that is practical to prolong the life of such material." Another road did not think it practical account of the different weights of rail used on their line.
3. Q.—Are you boring switch ties for spike holes prior to treatment?
   A.—All the replies were negative.
4. Q.—Do you recommend the boring of switch ties for spike holes prior to treatment?
   A.—Three roads replied in the "affirmative," sixteen "no" and the balance had different opinions as follows:
   Most of holes would be different and difficult to keep material in sets, due to the different weights of rail in use.
   Impractical and too costly.
   Difficult to locate the holes properly; probability that turnouts would not be bored to proper line.
   Switch ties would have to be spaced accurately on ground to have the rail conform to the borings.
   Switch ties are not replaced as a rule on account of decay, but are short lived because of the mechanical wear to which they are subjected.
   The penetration received without pre-boring sufficient to preserve the tie until destroyed by mechanical wear.
5. Q.—If you do not approve of boring spike holes in the entire switch tie, do you think it advisable to bore the switch tie for the main line only (as this is the most used) leaving the turnout side of the track unbored?
   A.—Five roads replied in the "affirmative," ten "no," other replies were as follows:
   Track forces would have difficulty in placing the switch properly in the track according to borings.
   Not economical as switch ties were mostly removed account of mechanical wear.
   Impracticable on account of the tiespacing and switch plates.

6. Q.—If you approve of boring the main line spike holes in the switch ties, do you think that it would be an economical proposition to bore the switch ties approximately at the location of the turnout rail, in order to obtain a better penetration of the preservative under the rail, no attempt being made to determine the exact location of the spike hole on the turnout side?

A.—Two roads replied in the "affirmative," fifteen "no," others as follows:

Would not be an economical proposition.

Believe the main line portion of ties will need renewal from mechanical wear before ties will rot out under turnout rails.

Do not believe it advisable to undertake to bore switch ties as there are many things which cause enough variation in the condition of the ties to make the holes useless.

Too many complications in boring switch ties to warrant going into it. The boring will all have to be done by hand, as machines used at the tie treating plants would not take the lengths of timber, and we do not believe the benefit would be worth the extra cost.

It has been our experience that switch ties removed from track have failed principally on account of mechanical wear, rather than decay, and it is therefore our opinion that the boring of switch ties for spike holes would not warrant the expense entailed.

Conclusion

1. It is the opinion of the Committee that the pre-boring of bridge ties for spike holes prior to treatment is practicable and an economical thing to do.

2. That the pre-boring of switch ties for spike holes prior to treatment, either for the main line or turnout rails is to be left to each road to do as they see fit.

3. It is recommended that the conclusions be accepted and printed in the Manual.

■

REPORT OF COMMITTEE VII—WOODEN BRIDGES AND TRESTLES

H. AUSTILL, *Chairman;*
J. B. MADDOCK, *Vice-Chairman;*
F. E. BATES,
C. H. CHAPIN,
C. R. CHEVALIER,
H. M. CHURCH,
F. H. CRAMER,
R. G. DEVELIN,
THEO. DOLL,
W. R. EDWARDS,
A. F. FRENDBERG,
S. F. GREAR,
A. B. B. HARRIS,
R. P. HART,
W. E. HAWLEY,
REUBEN HAYES,
W. B. HODGE,
C. J. HOGUE,
E. A. JOHNSON,
R. W. KENNEDY,
J. A. NEWLIN,
G. W. REAR,
ARTHUR RIDGWAY,
C. P. SCHANTZ,
D. W. SMITH,
M. A. STAINER,
G. C. TUTHILL,
J. L. VOGEL,
WM. WALKDEN,

Committee.

To the American Railway Engineering Association:

Your Committee respectfully presents herewith report covering the following subjects:

(1) Revision of Manual (Appendix A).
(2) Simplification of grading rules and classification of timber for railway uses, collaborating with other organizations dealing with this subject (Appendix B).
(3) Standardization and simplification of store stock and disposition of material reaching obsolescence, collaborating with other committees and organizations concerned (Appendix C).
(4) Overhead wooden or combination wooden and steel highway bridges, collaborating with Committees VIII—Masonry and XV—Iron and Steel Structures (Appendix D).
(5) Design of standard wooden trestles with a view of obtaining greater economy and conserving timber resources (Appendix E).
(6) Relative merits of concrete and treated wooden piles, collaborating with Committees VIII—Masonry, and XVII—Wood Preservation.

Action Recommended

1. That no changes be made in the Manual at this time.
2. That Appendix B be received as information and subject continued.
3. That Appendix C be received as information and subject continued.
4. That Appendix D be received as information and subject continued.
5. That the subject be discontinued and the Committee review plans now in the Manual with a view of preparing plans for heavier loading than those plans provide for.
6. That the subject be discontinued or changed to "Relative merits of concrete and treated wooden trestles."

It was with deep regret that the Committee learned of the death, on August 2, 1930, of Mr. William Albert McGonagle, President of the Duluth, Missabe & Northern Railway Company.

Mr. McGonagle presented the first report that this Committee made to the Association.

Respectfully submitted,

THE COMMITTEE ON WOODEN BRIDGES AND TRESTLES,

H. AUSTILL, *Chairman.*

Bulletin 332, December, 1930.

Appendix A

(1) REVISION OF MANUAL

G. C. Tuthill, Chairman, Sub-Committee; F. H. Cramer, W. E. Hawley, C. J. Hogue, J. A. Newlin, Arthur Ridgway.

The Committee recommends no changes in the Manual this year, but begs to call attention to certain typographical errors in the 1929 edition which were corrected last year but not listed in the 1930 Supplement.

Appendix B

(2) SIMPLIFICATION OF GRADING RULES AND CLASSIFICATION OF TIMBER FOR RAILWAY USES, COLLABORATNG WITH OTHER ORGANIZATIONS DEALING WITH THIS SUBJECT

W. E. Hawley, Chairman, Sub-Committee; C. R. Chevalier, H. M. Church, A. F. Frendberg, Reuben Hayes, C. J. Hogue, R. W. Kennedy, J. A. Newlin, C. P. Schantz.

This Sub-Committee has been keeping in contact with the lumber industry through the service of its Chairman, W. E. Hawley, as a member of the Central Committee on Lumber Standards, C. J. Hogue, in Charge Technical Service, West Coast Lumbermen's Association, and J. A. Newlin, in Charge Section of Timber Mechanics, Forest Products Laboratory.

No Washington Conference on Lumber Standards was found necessary in 1930. A combined meeting of the Central Committee and Consulting Committee on Lumber Standards was held at Chicago on April 22, 1930. At this meeting only minor changes were made and are deemed by this Committee as of not enough importance to be included in revisions of the Manual this year. The California Redwood Association presented its new California Redwood Structural Grades which were approved by the two committees as conforming to the basis for American Lumber Standards.

In order to avoid confusion between "Structural" and "Yard" grades, the above Committees decided to add the word "Structural" after the words "Dense Select," "Select," "Dense Common" and "Common" in specifying timber for structural use.

In a report of the present status of application of the provisions of the American Lumber Standards, the Secretary of the Central Committee on Lumber Standards advised that based on information available, it was estimated that fully 90 per cent of all softwood lumber produced and graded under the rules of the recognized softwood lumber manufacturers' associations was American Standard Lumber.

Grade, trade or species marking has made rapid progress to the extent that approximately eight billion feet of marked lumber in softwoods, including also considerable hardwood lumber, is now available annually.

Consumers are urged to base their purchasing and specification practices on manufacturers' associations rules conforming to the revised standards.

This Committee would also urge that timber bought for structural use be specified on the structural grades rather than the old rules specifying square edge and sound or merchantable. These latter terms have no basis of strength determination.

Appendix C

(3) STANDARDIZATION AND SIMPLIFICATION OF STORE STOCK AND DISPOSITION OF MATERIAL REACHING OBSOLESCENCE, COLLABORATING WITH OTHER COMMITTEES AND ORGANIZATIONS CONCERNED

S. F. Grear, Chairman, Sub-Committee; A. F. Frendberg, R. P. Hart, Reuben Hayes, W. B. Hodge, C. J. Hogue, R. W. Kennedy, D. W. Smith, M. A. Stainer, J. L. Vogel, Wm. Walkden.

The Sub-Committee has made use of data previously collected by the Committee on Wooden Bridges and Trestles, and finds a very great variety of sizes and lengths of bridge materials. The Association has adopted several standards for timber trestles, but very little progress has been made in getting the various railroads to adopt these standards. The Committee feels that a more general use of the sizes and lengths shown on the plans for these Association standards would result in the simplification of manufacture of bridge timbers, and this in turn would affect the simplification of storehouse stocks and permit the reduction of such stocks.

Some suggestions are proposed herewith, to bring about the simplification of stocks:

(1) The use of materials of the same size for ties or guard timbers on steel bridges and timber trestles. This would also be applicable to the hardware used.

(2) The use of timbers of the same size in open deck and ballast deck trestles, where both types are in use on one railroad.

(3) The use of timber of standard cross-section for sills, caps or posts of frame trestles and other structures where the lengths cannot be standardized.

(4) Sizes of material used should conform as nearly as possible to the standard commercial size adopted as the American Lumber Standards.

(5) The use of pile stubs for foundations of buildings, eliminating the necessity of carrying stocks of timber for this purpose.

(6) The use of any obsolete timber or timber of odd sizes for mud blocks for frame trestles, platforms, buildings and platform curbs. In some cases it may be advisable to re-work such timber into smaller sized material.

(7) The use in concrete forms of lumber rejected for other purposes. One railroad reports having made use of rejected car material for this purpose.

(8) When a certain size or class of timber or piling is overstocked, it may be found to be more economical to give it a light treatment for preservation of the sapwood, rather than to attempt to dispose of it or re-work it.

(9) It is recommended that emergency stocks of timber carried at points other than general supply yards should be treated.

(10) The Engineering and Maintenance Departments should examine the stock lists periodically and, when special material is to be ordered, determine if substitutions can be made from stock.

(11) The Engineering and Maintenance Departments should keep the Store Department informed as closely as possible on future needs.

(12) Each drawing should be examined with a view of eliminating material which is not standard stock. This is especially important for treated material which must be seasoned before treatment.

(13) Co-operation of all departments using this material, such as Bridge, Building and Mechanical Departments, with a view of reducing the number of standard sizes and grades.

(14) Store Departments should advise all departments concerned of special stocks or overstocks of certain materials.

There seems to be little reason for bridge timbers reaching obsolescence if store stocks are properly watched. Such material could ordinarily be used for repairing existing structures.

The Committee also desires to call attention to Committee reports of "Purchases and Stores Division—A.R.A." as follows:

Report of Committee, Subject V—Forest Products, page 171 of May, 1925, Proceedings.

Report of Committee, Subject XVI (A) Standardization and Simplification of Stores Stocks. (B) Disposition of Surplus or Inactive Materials, page 217, of June, 1928, Proceedings.

The Committee feels that much can be accomplished in the reduction of storehouse stocks by an exchange of ideas, and that this Committee should be a clearing house for suggestions and would greatly appreciate having such suggestions forwarded to the Chairman of the Sub-Committee by all members of the Association.

The Committee recommends that the above be received as information, and that the work of the Committee be continued next year.

Appendix D

(4) OVERHEAD WOODEN OR COMBINATION WOODEN AND STEEL HIGHWAY BRIDGES, COLLABORATING WITH COMMITTEES VIII—MASONRY, AND XV—IRON AND STEEL STRUCTURES

R. P. Hart, Chairman, Sub-Committee; C. H. Chapin, F. H. Cramer, R. G. Develin, S. F. Grear, J. B. Maddock, G. W. Rear, G. C. Tuthill, J. L. Vogel, Wm. Walkden.

The Sub-Committee has made further study of the data previously assembled and presents for consideration two typical plans for timber highway overhead bridges, one with concrete floor slab and the other with laminated timber floor and four suggested types of wearing surface.

The two plans presented do not cover the ground fully but the Committee found it impractical to prepare plans covering the use of all kinds and grades of timber available throughout the country and for the innumerable conditions which may be encountered in preparing plans for separated crossings. Two commonly used kinds of timber were therefore selected for use in preparing the plans presented, the working stresses for each being the same for timber occasionally wet but quickly dry.

For the purpose of the estimates given below the following assumptions were made:

(a) Location in the vicinity of St. Louis.
(b) Timber Select Grade Dense Southern Pine.
(c) Angle of crossing 90 degrees.
(d) Width of roadway 20 feet between curbs.

(e) Length of bridge 5 panels at 21 ft. to accommodate single track crossing.
(f) Bents made of piling having 18 to 20 feet of penetration.
(g) Unit prices include labor, material, transportation at commercial rates, rental of equipment, work train service for unloading at site or team haul from nearest station and the usual surcharges for store expense, accounting, supervision and use of small tools.

Bridge with Laminated Timber Floor and Asphalt Plank Wearing Surface

Creosoted timber piles in place	920 Lin. ft.	@	$ 1.35	—$1240
Creosoted timber in place	35700 FBM	@	.125	— 4470
Hardware in place	2000 Lb.	@	.05	— 100
Paint applied on hand rail	5 Gal.	@	4.00	— 20
Asphalt Plank (1½") in place	2280 Sq. ft.	@	.35	— 800
Engineering and Contingencies	10 per cent			670
			Total	$7300

Bridge with Concrete Floor Slab

Creosoted timber piles in place	1150 Lin. ft.	@	$ 1.35	—$1550
Creosoted timber in place	17000 FBM	@	.125	— 2125
Hardware in place	1500 Lb.	@	.05	— 75
Concrete floor slab in place	60 Cuyd.	@	20.00	— 1200
Concrete rail posts in place	32 Each	@	5.00	— 160
Reinforcing steel in place	10000 Lb.	@	.05	— 500
Gas pipe rails in place	425 Lin. ft.	@	1.00	— 425
Paint applied on rails	5 Gal.	@	1.00	— 425
Asphalt sheets for joints in roadway slab	50 Sq. ft.	@	.20	— 10
Engineering and Contingencies	10 per cent			605
			Total	$6670

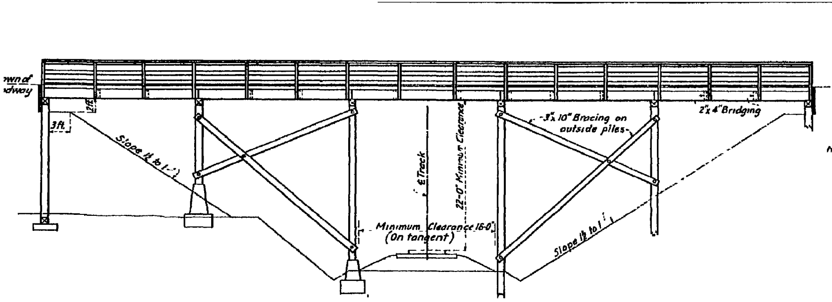
The Committee recommends that this report be received as information and that the work of the Committee be continued for another year to permit collaboration with other committees and some field inspection trips to examine existing highway bridges of the different types.

Appendix E

(5) DESIGN OF STANDARD WOODEN TRESTLES WITH A VIEW OF OBTAINING GREATER ECONOMY AND CONSERVING TIMBER RESOURCES

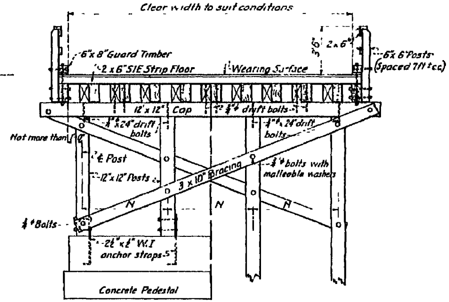
A. B. B. Harris, Chairman, Sub-Committee; C. R. Chevalier, H. M. Church, Theo. Doll, W. R. Edwards, W. B. Hodge, E. A. Johnson, J. B. Maddock, J. A. Newlin, D. W. Smith.

No suggestions have come before the Committee which are considered an improvement over plans now in the Manual and a study of this material and comparison with substitute designs has convinced the Committee that the plans now in the Manual comply with the requirements of economy in design and conservation of timber resources.

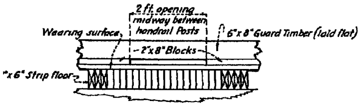


HALF ELEVATION
SHOWING FRAMED BENTS

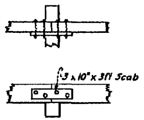
HALF ELEVATION
SHOWING PILE BENTS



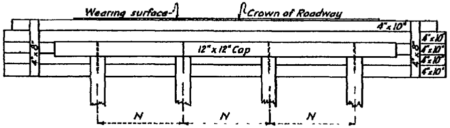
HALF FRAMED BENT   HALF PILE BENT



DETAIL OF DRAIN



SPLICE FOR OUTSIDE STRINGERS



BACKING FOR END BENT

SPAN (c c bents)	SIZE OF STRINGERS (Max Spacing 2-2" c c)	MAXIMUM SPACING "N"
13'-0"	6" x 14"	6'-0"
14-0"	7" x 14", 6" x 15"	6'-0"
15-0'	7" x 14", 6" x 15"	6'-0"
16-0"	6" x 16"	6'-0"
17-0'	7½" x 15", 6" x 17'	6'-0'
18'-0"	7½" x 15", 6 x 17"	6'-0
19'-0"	7" x 16"	6'-0"
20'-0"	6' x 18"	6-0"
21'-0"	8" x 16"	6'-0"
22'-0"	7" x 18"	6'-0"
23'-0"	9' x 16", 8" x 17"	5'-9"
24'-0"	10" x 16"	5'-6"
25'-0"	9" x 17", 8" x 18'	5'-6"
26'-0"	9" x 18"	5'-3"
27'-0"	9" x 18"	5'-0"
28'-0'	10" x 18", 8" x 20"	5'-0"
29-0'	10" x 18', 8' x 20"	4'-9"
30 0"	10" x 20"	4'-6"
31'-0'	10" x 20"	4'-6"
32'-0"	10" x 20"	4'-3"
33 0"	10" x 20"	4'-0"

NOTES:

Loading .... A R E A H-15 Truck loading.

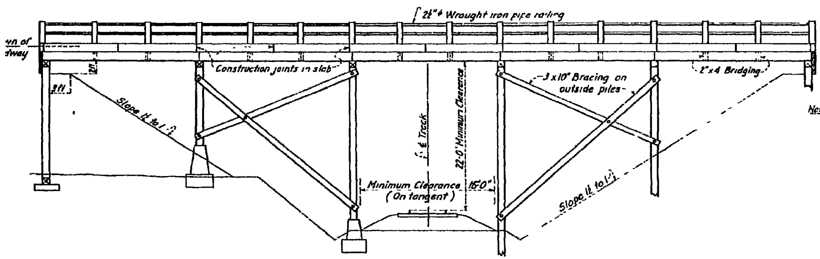
Timber .... Dense Southern Pine, select grade, or dense Douglas Fir, select grade, treated with an approved preservative.
Working stresses, A R E A Manual, 1929 edition, for timber occasionally wet but quickly dried.
Stringers to be sized to a uniform depth one half inch less than nominal depth for a length of two feet from each end only.
All field holes and field cuts to be treated with preservative.
Holes to be bored same size as bolts to be placed therein.
Timber in handrail to be painted white.

Concrete .... Twenty eight day strength of concrete to be 2000 lbs.
Size and depth of footings to be made to suit soil conditions.

Wearing Surface .... To be one of the following,
1 One and one half inch asphalt plank laid longitudinally in hot pitch.
2 Corrugated steel traffic treads, 24" wide 4 lines @ 5 ft (±) c c.
3 Asphalt mastic one half inch or more in thickness.
4 Timber plank laid diagonally with roadway.

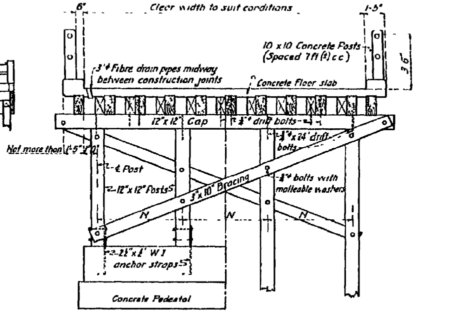
TYPICAL PLAN
FOR
TIMBER HIGHWAY OVERHEAD BRIDGE
WITH
LAMINATED TIMBER FLOOR
A.R.E.A

1120-30

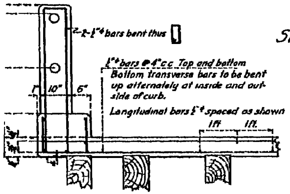


HALF ELEVATION SHOWING FRAMED BENTS

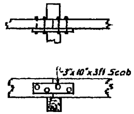
HALF ELEVATION SHOWING PILE BENTS



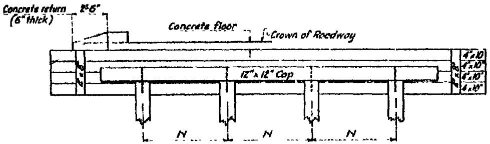
HALF FRAMED BENT HALF PILE BENT



CONCRETE SLAB



SPLICE FOR OUTSIDE STRINGERS



BACKING FOR END BENT

SPAN (c.c bents)	SIZE OF STRINGERS (Max Spacing 2-2" c c)	MAXIMUM SPACING "N"
13'-0"	6"x 14	6'-0'
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15'-0"	7'x 14," 6"x 15"	6'-0"
16-0"	6"x 16"	6'-0"
17'-0"	6"x 16"	6'-0"
18 0"	7½"x 15," 6"x 17"	6'-0"
19'-0"	7"x 16"	6'-0"
20'-0"	6"x 18"	5'-9
21'-0"	8 x 16"	5'-6"
22-0"	7'x 18"	5'-3
23'0"	9 x 16," 8"x 17"	5'-0
24-0'	10"x 16"	5'-0'
25-0"	9"x 17," 8"x 18"	4'-9"
26 0"	9"x 18"	4'-6"
27-0"	9"x 18"	4-6
28 0"	8"x 20"	4-3"
29 0"	10"x 18	4'-3"
30'0"	10"x 20"	4'-0"
31-0"	10"x 20"	3'-9
32-0	10"x 20"	3'-9"
33'0	10"x 20"	3'-6"

NOTES.

Loading ...... A R E A H-15 Truck loading

Timber...... Dense Southern Pine, select grade, or dense Douglas Fir, select grade, treated with an approved preservative.
Working stresses, A R E A Manual, 1929 edition, for timber occasionally wet but quickly dried.
Stringers to be sized to a uniform depth one half inch less than nominal depth for a length of two feet from each end only.
All field holes and field cuts to be treated with preservative.
Holes to be bored same size as bolts to be placed therein

Concrete Twenty eight day strength of concrete in slabs to be 3000 lbs, in footings, 2000 lbs.
Working stresses and workmanship, A R E A Manual, 1929 edition.
Bevel 90° edges one inch.
Size and depth of footings to be made to suit soil conditions.

Reinforcing steel... To be deformed section, new billet stock, structural grade steel.

TYPICAL PLAN
FOR
TIMBER HIGHWAY OVERHEAD BRIDGE
WITH
CONCRETE FLOOR
A R E A

11-20-30

REPORT OF COMMITTEE XVIII—ELECTRICITY

SIDNEY WITHINGTON, *Chairman;*
F. AURYANSEN,
B. F. BARDO,
H. M. BASSETT,
R. BEEUWKES,
L. S. BILLAU,
D. J. BRUMLEY,
H. C. CROSS,
H. A. CURRIE,
J. C. DAVIDSON,
J. H. DAVIS,
C. L. DOUB,
H. L. ETHERIDGE,
J. S. HAGAN,
S. W. LAW,
PAUL LEBENBAUM,
W. P. MONROE,
J. V. B. DUER, *Vice-Chairman;*
W. L. MORSE,
R. J. NEEDHAM,
E. H. OLSON,
A. E. OWEN,
J. A. PEABODY,
H. W. PINKERTON,
J. T. SEAVER,
W. M. VANDERSLUIS,
J. H. VANBUSKIRK,
H. M. WARREN,
L. S. WELLS,
L. C. WINSHIP,
C. G. WINSLOW,
R. P. WINTON,
G. I. WRIGHT,

Committee.

To the American Railway Engineering Association:

In lieu of a detailed report, your Committee on Electricity refers to the reports made to the Electrical Section, presented and acted on at the October, 1930, session of the Electrical Section. These reports have been reprinted in full in Bulletin 328, August, 1930.

As a matter of record, a synopsis of the work of the Electrical Section for the past year is given below:

1. Revision of Manual

(a) Specifications for Black Varnished Cloth Tape—Straight and Bias Cut, were approved for insertion in the Manual.

(b) Recommended Practice for the Protection of Tracks Used in the Loading or Unloading of Inflammable Liquids from Danger of Fire Caused by Electric Sparks, were approved and substituted for the corresponding rules in the Manual.

2. Inductive Co-Ordination

The Committee reported progress on the formulation of Principles and Practices for Inductive Co-Ordination, in cooperation with other interests concerned.

3. Power Supply

This Committee made a comprehensive report on (a) Steam power available for traction and general power purposes; (b) Water power available for traction and general power purposes; (c) Internal combustion engine power supply.

The Power Supply Committee interpreted its functions to be (a) To study and classify electric power requirements for the railroads; (b) to acquaint the railroads with the major sources of power supply; (c) to study methods of production and distribution for utilization on railroads and other industries.

The report contains interesting statistics on primary power available in the United States and Canada for traction and general power purposes.

Bulletin 332, December, 1930.

4. Electroylsis

This Committee has continued its study of electrolysis and the measures taken to mitigate electrolysis in connection with the Cleveland Union Terminal and Delaware, Lackawanna & Western electrifications.

5. Cooperation in Miscellaneous Regulations

The Committee reports progress in the negotiations with the National Electric Light Association in the preparation of Principles and Practices for power wire crossings over railroads, with accompanying specifications.

6. Overhead Transmission Line and Catenary Construction

The activities of this Committee have been largely confined to the consideration of detail specifications covering component parts of catenary construction to supplement the main specifications. Tentative Specifications for Copper Trolley Wire and Specifications for Bronze Trolley Wire are included in the report.

7. Economics of Railway Location as Affected by Electric Operation

This Committee is collaborating with Committee XVI—Economics of Railway Location, in the preparation of information regarding the selection of electric switching locomotives.

8. Standardization of Insulating Tape

This Committee submitted for approval and insertion in the Manual of the Electrical Section, Specifications for Black Varnished Cloth Tape—Straight and Bias Cut.

9. Standardization of Insulators

This Committee has kept in touch with developments and has given consideration to making certain changes in the Specifications for Porcelain Insulators for Railroad Supply Lines, particularly the requirement of a "sanded belt," but is not prepared to make any changes at the present time.

11. Protection of Oil Sidings from Danger Due to Stray Currents

The Committee offered a revision of the current rules. Recent studies and developments in the field of protection from danger due to electrical ignition of inflammable liquids have indicated the need of a simple method, universally applied, for protection against danger from what is known as static electricity. The revision of the current rules offered for approval as recommended practice provides for such protection.

12. Specifications for Track and Third-Rail Bonds

In collaboration with the Committee on Heavy Electric Traction of the American Electric Railway Engineering Association, this Committee has presented tentative Specifications for Stud Terminal Copper Rail Bonds.

The Committee has also given study to methods of joining third-rails to provide electrical conductivity, such as welding, combination of copper bar,

bolts and solder, and similar practices; a study of contact areas and resistances for welded bonds.

13. Illumination

The Incandescent Lamp Standards have been revised and brought up to date. The Specifications for Large Tungsten Filament Incandescent Lamps have been slightly revised. The Committee also reports on floodlighting of railroad yards.

14. Design of Indoor and Outdoor Sub-Stations

This Committee's report covers (a) substation insulation; (b) working clearances, and (c) relay protection.

15. High Tension Cables

The Committee has obtained data relative to cable installations of over 25,000 volts, and reports progress on its assignment.

16. Application of Corrosion-Resisting Materials to Railroad Electrical Construction

The Committee has continued the study of the application of corrosion-resisting materials to railroad electrical construction, with comprehensive tests of materials. Samples for corrosion tests were installed in the smoke jacks at Cedar Hill enginehouse, New Haven. Samples are also to be installed in the Hemphill Tunnel and at Lambert's Point Pier on the Norfolk & Western Railway.

17. Form for Power Contract for Large Blocks of Power

This Committee is collaborating with Committee XX—Uniform General Contract Forms, in the preparation of "Form of Agreement for the Purchase of Electrical Energy in Large Volume."

Action Recommended

1. That the report of the Committee on Electricity be accepted as information.

Respectfully submitted,

THE COMMITTEE ON ELECTRICITY,

SIDNEY WITHINGTON, *Chairman.*

REPORT OF COMMITTEE VIII—MASONRY

C. P. RICHARDSON, *Chairman;*
J. T. ANDREWS,
F. E. BATES,
G. E. BOYD,
KENNERLY BRYAN, JR.,
M. F. CLEMENTS,
T. L. CONDRON,
HARDY CROSS,
W. F. CUMMINGS,
THEO. DOLL,
G. F. EBERLY,
T. L. D. HADWEN,
B. V. HAEGERT,
J. L. HARRINGTON,
A. D. HARVEY,
W. K. HATT,
A. C. IRWIN,
C. S. JOHNSON,
G. M. JOHNSON,
A. R. KETTERSON,
J. A. LAHMER,

M. HIRSCHTHAL, *Vice-Chairman;*
A. N. LAIRD,
J. F. LEONARD,
J. P. MACK,
C. R. MONTGOMERY,
L. E. RITTER,
D. A. RUHL,
D. B. RUSH,
F. E. SCHALL,
C. P. SCHANTZ,
L. W. SKOV,
A. W. SMITH,
G. L. STALEY,
I. F. STERN,
J. H. TITUS,
L. W. WALTER,
C. C. WESTFALL,
C. A. WHIPPLE,
C. C. WILLIAMS,
P. H. WINCHESTER,
J. J. YATES,

Committee.

To the American Railway Engineering Association:

Your Committee respectfully presents herewith report covering the following subjects:

(1) Revision of the Manual (Appendix A).
(2) Principles of Design of Plain and Reinforced Concrete (Appendix B).
(3) Science and Art of Concrete Manufacture (Appendix C).
(4) Contact with the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete (Appendix D).
(6) Waterproofing Masonry Structures (Appendix E).
(9) Repair of Deteriorating Concrete (Appendix F).

The Committee reports progress on (5)—Foundations, (7)—Tunnels, and (8)—Clearances.

Special Committee on Waterproofing.

The following resolution was unanimously adopted by the Committee:

> "Resolved, That the Board of Direction of the American Railway Engineering Association create a Special Committee on Waterproofing of Railway Structures, to be composed of the members of the Committees on Masonry, Iron and Steel Structures, and Buildings, each of the latter committees to appoint such members."

Action Recommended

1. That the changes in the Manual in Appendix A be approved and that the complete Specifications for Portland Cement, as revised, be printed in the current supplement to the Manual.

2. That the Specifications for the Design of Concrete Transmission Poles, in Appendix B, be approved for publication in the Manual.

3, 4, 6 and 9. That reports on these subjects be received as information.

Respectfully submitted,

THE COMMITTEE ON MASONRY,

C. P. RICHARDSON, *Chairman.*

Bulletin 332, December, 1930.

Robert Armour

Born at Montreal, March 6, 1850, the son of John Armour and the grandson of Robert Armour, who came to Canada from Scotland in 1796 and settled in Montreal.

He was a small boy when his father moved to New York. After a few years the family moved to Windsor, Ont.

At the age of 16 he enlisted in the Windsor Garrison Artillery in service against the Fenian Raiders, in 1866.

He entered the service of the Canadian National Railways (Great Western Railway) as draftsman at Hamilton, Ont., July 12, 1870, was appointed Assistant Engineer June, 1875; Principal Asst. Engineer to the late Joseph Hobson, Chief Engineer, September 1, 1881; was transferred to Montreal as Assistant Engineer, Grand Trunk Railway, August 1, 1896; appointed Masonry Engineer October 1, 1917; transferred to Toronto as Masonry Engineer, Central Region, Canadian National Railways, March, 1923. On February 1, 1924, Mr. Armour retired from active service, after serving faithfully for 54½ years continuously. However, on account of his wide experience in matters pertaining to his occupation he was retained in the capacity of Consulting Masonry Engineer, Canadian National Railways, Central Region, until date of death.

Mr. Armour joined the American Railway Engineering Association in February, 1909, and served on the Committee on Masonry continuously from 1913 to 1925 inclusive, and contributed faithfully and well to its work.

As a railway man his chief concern was the substructure of bridges and he had a part in the rebuilding of many for the double track between Chicago and Portland, Maine. Some outstanding ones being bridges at St. Anne de Bellevue and Vaudreuil, the Arch at Niagara Falls and the Victoria Bridge at Montreal. He was also interested in the masonry approaches to the St. Clair Tunnel.

He died suddenly on the evening of September 10, 1930, after some months of failing health and was buried in Montreal in the family lot in Mount Royal Cemetery.

He is survived by his wife and a daughter.

Appendix A

(1) REVISION OF MANUAL

J. F. Leonard, Chairman, Sub-Committee; M. Hirschthal, Hardy Cross, T. L. Condron, G. F. Eberly, A. R. Ketterson, J. A. Lahmer, D. B. Rush, L. W. Skov, L. W. Walter.

SPECIFICATIONS FOR PORTLAND CEMENT

Your Committee recommends the adoption of the following revisions and additions to the Specifications for Portland Cement now appearing on pages 616-633, inclusive, of the Manual to conform to revised specifications designated as A.S.T.M. C9-30 and A.S.T.M. C77-30 and that the complete specification, as revised, be published in the current issue of the Supplement to Manual of Recommended Practice.

The proposed revisions of the present recommended practice are as follows:

Present:
Article
6

Age at Test Days	Storage of Briquets	Tensile Strength Lb. per sq. in.
7	1 day in moist air, 6 days in water	225
28	1 day in moist air, 27 days in water	325

Proposed:
Article
6

Age at Test Days	Storage of Briquets	Tensile Strength Lb. per sq. in.
7	1 day in moist air, 6 days in water	275
28	1 day in moist air, 27 days in water	350

Proposed: (New)
Article
16

The cement shall be sampled and tested in accordance with the Standard Methods of Testing Cement (A.S.T.M. Designation: C77) of the American Society for Testing Materials.

Proposed Addition to Article 28.

NOTE.—The balances used in the chemical analysis shall conform to the following requirements: capacity not less than 100 g. in each pan; the two arms of beam to be equal to within one part in 100,000; capable of reproducing results within 0.1 mg.; sensibility reciprocal (see Section 16, Note 1 (c) not more than 0.2 mg. per division of the graduated scale. The weights used in the chemical analysis shall conform to the requirements of the U.S. Bureau of Standards specifications for Class "S" weights as contained in Bureau of Standards Circular No. 3.

Present:
Article
31

(3) Use of a balance which will give results correct within 5 mg. and sufficiently sensitive so that the rest point will be deflected at least two divisions of the scale for an added load of 5 mg.

Proposed:
Article
31

(3) The "balance" used in making the fineness test shall conform to the following requirements: The balance shall be enclosed in a glass case. On balances in use the tolerance at a load of 50 g. shall be 0.05 g., and at loads less than 0.1 g. the tolerance shall be 0.01 g. (The tolerances on new balances shall be one-half of the values given.)

The maximum "sensibility reciprocal," allowable at each of the loads specified above shall be twice the value of the tolerance specified for the load in question. The sensibility reciprocal is a measure of the sensitivity of a balance, and is the weight required to move the position of equilibrium of the beam, pan, pointer, or other indicating device of a scale a definite amount at the capacity or at any lesser load. For a complete definition of sensibility reciprocal see U.S. Bureau of Standards "Handbook M 85, pp. 80-82.

The tolerances in excess or deficiency on the weights in use in the fineness test shall be as follows:

Weight	*Tolerance*	*Weight*	*Tolerance*
50 g.	0.04 g.	0.500 g.	0.003 g.
20 g.	0.02 g.	0.200 g.	0.002 g.
10 g.	0.014 g.	0.100 g.	0.001 g.
5 g.	0.010 g.	0.050 g.	0.001 g.
2 g.	0.006 g.	0.020 g.	0.001 g.
1 g.	0.004 g.	0.010 g.	0.001 g.

The tolerances on new weights shall be one-half the values given.

Proposed Additions to Article 33

NOTE 2.—The scales used in weighing materials for neat cement and mortar mixes shall conform to the following requirements: On scales in use the tolerance at a load of 1000 g. shall be ±1.0 g. (The tolerance on new scales shall be one-half of the value given.) The sensibility reciprocal (See Section 32, Note 1 (c) shall not be greater than twice the tolerance.

The tolerances in excess or deficiency os the weights in use in weighing materials for neat cement and mortar mixes shall be as follows:

Weight	*Tolerance*	*Weight*	*Tolerance*
1000 g.	0.5 g.	20 g.	0.05 g.
500 g.	0.35 g.	10 g.	0.04 g.
200 g.	0.20 g.	5 g.	0.03 g.
100 g.	0.15 g.	2 g.	0.02 g.
50 g.	0.10 g.	1 g.	0.01 g.

The tolerances on new weights shall be one-half the values given.

NOTE 3.—Glass graduates of 100-ml. to 200-ml. capacities used for measuring the mixing water shall be made to deliver the indicated volume at 20°C. (68°F.). The tolerance on these graduates shall be ± 1.0 ml.

Proposed Addition to Article 35

In addition to the above, the Vicat apparatus shall conform to the following requirements:

Weight of plunger............300 g. ± 0.5 g. (0.661 lb. ± 8 grains)
Diameter of larger end of plunger..1 mm. ± 0.02 mm. (0.394 in. ± 0.001 in.)
Diameter of needle....1 mm. ± 0.01 mm. (0.039 in. ± 0.0005 in.)
Inside diameter of ring at bottom....7 cm. ± 3 mm. (2.75 in. ± 0.12 in.)
Inside diameter of ring at top..6 cm. ± 3 mm. (2.36 in. ± 0.12 in.)
Height of ring..............4 cm. ± 0.5 mm. (1.57 in. ± 0.02 in.)

Proposed Addition to Article 45

In addition to the above, the Gillmore needles shall conform to the following requirements:

Initial Needle:
Weight..................1/4 lb. ± 8 grains (113.4 g. ± 0.5 g.)
Diameter..........1/12 in. ± 0.001 in. (2.11 mm. ± 0.02 mm.)
Final Needle:
Weight...................1 lb. ± 8 grains (453.6 g. ± 0.5 g.)
Diameter..........1/24 in. ± 0.001 in. (1.06 mm. ± 0.02 mm.)

Proposed Addition to Article 47

. . . The dimensions of the briquet molds shall conform to the following requirements: width of mold, between inside faces, at waist line of briquet, 1 in. ± 0.01 in., thickness of mold 1 in. ± 0.004 in. The tolerance on new molds shall be one-half the values given.

Present Article 52

The briquets shall be tested as soon as they are removed from the water. Tests may be made with any machine meeting the following requirements: The machine shall be capable of weighing the applied load within 0.5 per cent of the nominal value. The sensibility reciprocal (the weight required to be added to the load to move the beam from a horizontal position of equilibrium to a position of equilibrium at the top of the trig loop) shall not exceed 1 lb. at full capacity of the machine or at any lesser load. The clips for holding the tension test specimens shall be in accordance with Fig. 7. The bearing surfaces of the clips and briquets shall be free from sand or dirt, and the roller bearings shall be well oiled and maintained so as to insure freedom of turning. The briquets shall be carefully centered in the clips and the load applied continuously at the rate of 600 lb. per minute.

Proposed Article 52

The briquets shall be tested as soon as they are removed from the water. Tests may be made with any machine meeting the following requirements: The error for loads of not less than 100 lb. shall not exceed ± 1.0 per cent for new machines or ± 1.5 per cent for used machines. The clips for holding the tension test specimens shall be in accordance with Fig. 7. The bearing surfaces of the clips and briquets shall be free from sand or dirt, and the roller bearings shall be well oiled and maintained so as to insure freedom of turning. The briquets shall be carefully centered in the clips and the load applied continuously at the rate of 600 lb. ± 25 lb. per minute.

Proposed Addition to Article 56

The relative humidity of the moist closet shall not be less than 90 per cent.

Numbering of articles:

Due to inclusion of new Article 16, all numbers 16-57, inclusive, to be renumbered 17-58 inclusive.

Present Article 3

Grading of Fine Aggregate

Fine aggregate shall range in size from fine to coarse within the limits indicated below, percentage by weight:

Passing through No. 4 sieve		100 per cent
Passing through No. 50 sieve	Not more than	30 per cent
	Not less than	10 per cent
Passing through No. 100 sieve, when screened dry	Not more than	6 per cent
Volume removed by sedimentation	Not more than	3 per cent

Proposed Article 3

Fine aggregate shall range in size from fine to coarse within the limits indicated below, percentage by weight:

Passing through No. 4 sieve		95 per cent
Passing through No. 50 sieve	Not more than	30 per cent
	Not less than	10 per cent
Passing through No. 100 sieve, when screened dry	Not more than	6 per cent
Volume removed by sedimentation	Not more than	3 per cent

Present Article 11

Reinforcement bars shall conform to the areas and equivalent sizes shown in the following table:

Sizes and Areas of Reinforcement Bars

Size of Bar In.	*Area Sq. In.* Round Bar	*Area Sq. In.* Square Bar
3/8	0.110	....
1/2	0.196	0.250
5/8	0.306	....
3/4	0.441	....
7/8	0.601	....
1	0.785	1.000
1 1/8	....	1.265
1 1/4	....	1.562

Proposed Article 11

Size of Bars

Reinforcement bars shall conform to the areas and equivalent sizes shown in the following table:

Sizes and Areas of Reinforcement Bars *

Size of Bar In.	*Area Sq. In.* Round Bar	*Area Sq. In.* Square Bar
3/8	0.110	....
1/2	0.200	0.250
5/8	0.310	....
3/4	0.440	....
7/8	0.600	....
1	0.790	1.000
1 1/8	....	1.270
1 1/4	....	1.560
1/4	0.050	....

* Simplified Practice Recommendation No. 26, effective September 2, 1930.

Present Article 17

Amount of Water
Class of Concrete

Compression Strength Lb. per sq. in. 28 days	Gallons of Water Per sack of Cement
3500	5.00
3000	5.50
2500	6.25
2000	7.00
1500	8.00

Proposed Article 17

Amount of Water
Class of Concrete

Compression Strength Lb. per sq. in. 28 days	Gallons of Water Per sack of Cement
3500	5.00
3000	5.50
2500	6.25
2000	7.00

Present Article 24

Time of Mixing

The mixing of each batch shall continue not less than one minute after all the materials are in the mixer, during which time the mixer shall rotate at a peripheral speed of about 200 ft. per minute.

Proposed Article 24

Time of Mixing

The mixing of each batch shall continue not less than one and one-half minutes after all the materials are in the mixer, during which time the mixer shall rotate at a peripheral speed of about 200 ft. per minute.

Appendix B

(2) PRINCIPLES OF DESIGN OF REINFORCED CONCRETE ARCHES AND TRANSMISSION POLES

M. Hirschthal, Chairman, Sub-Committee; Hardy Cross, T. L. Condron, Theo. Doll, J. L. Harrington, A. C. Irwin, C. S. Johnson, A. R. Ketterson, A. N. Laird, J. F. Leonard, L. E. Ritter, C. P. Schantz, L. W. Skov, A. W. Smith, G. L. Staley, I. F. Stern, C. C. Westfall, C. C. Williams.

Your Committee reports progress on the subject of Concrete Arches and presents the following principles for the Classification and Design of Reinforced Concrete Arches for Railroad Loadings, which are submitted as information and for suggestions. This data will subsequently be utilized as a basis for the preparation of recommended specifications for the Design and Construction of Reinforced Concrete Arches for Railroad Loadings:

A

I.—CLASSIFICATION OF ARCHES

Fixed or Hinged

1. Arches may be classified as hinged or fixed. Hinged arches may have one, two or three hinges, but the one and two-hinged types are not recommended. The hinged type is the one generally in use in American practice.

Form of Arch Ring

2. Arches may also be classified in accordance with the form of the intradosal curve as semi-circular, segmental, multicentered, parabolic or elliptical.*

* *Footnote*—In addition to the above forms or modifications thereof, there may be introduced short radius fillets tangent to the istradosal curve and to the face of the abutment or pier, to improve the appearance.

Type of Spandrel

3. The deck construction may be either the filled spandrel (wall) type or the open spandrel type.

II.—DESIGN

General

1. The topography, ground structure, soil tests or rock borings, and local requirements such as clearances, location of span openings, will indicate fairly definite limitations upon which to base the preliminary design. In the case of large or important structures, alternate layouts of span arrangement should be considered from the standpoint of the physical requirements, economics, and appearance before adopting the layout for the final design. For appearance, there should preferably be an odd number of spans symmetrically arranged in the structure, and, when conditions warrant a variation in the span lengths, the end spans should preferably be shorter than the central span or spans.

In open spandrel construction, the spandrel deck slab, transverse walls, beams, columns and other members above the arch ring or ribs shall be designed for the maximum stresses produced by the combination of the dead load, live loads and impact, as provided by Sections 84 to 126 incl. In special cases where the stresses produced are sufficient to materially influence the design, consideration shall be given to tractive wind and centrifugal forces and the effect of temperature changes.

In filled spandrel construction, the spandrel wall shall be designed as retaining walls using the normal earth pressure of the filling material, together with such train load surcharge against the wall surface as provided for surcharged retaining walls by Sections 136 to 138, inclusive.

The arch ring shall be designed for the maximum stresses produced by the combination of the dead load, live load, impact, temperature and rib shortening stresses, and where the stresses produced are sufficient to materially influence the design, allowance shall be made for tractive, wind and centrifugal forces.

Arch abutments and piers shall be designed for the most unfavorable combination of the forces and moments produced by the dead load, live load, temperature changes and rib shortening in the arch ring or rib. Consideration shall also be given to the stresses and foundation loads produced by wind, tractive and centrifugal and other forces. In long structures, piers at intervals shall be analyzed as abutment piers, for construction purpooses.

Loads

(a) Dead Load

2. The dead load shall consist of the entire estimated weight of the portion of the structure supported, including the member itself. The weights of unit quantities of various materials in use shall be assumed as follows

except in such cases as warrant a detailed investigation of the weights of the particular materials to be used by reason of special or unusual conditions or materials:

Track rails and fastenings	150 lb. lin. foot of track
Ballast	120 lb. cu. foot
Reinforced concrete	150 lb. cu. foot
Earth filling material	100 lb. cu. foot

(b) Live Load

The minimum live load for each track shall be the standard A.R.E.A. loading, or such portion thereof as will provide maximum stress.

In open spandrel construction, the deck slab, transverse beams, walls and columns shall be designed for concentrated live loads. The arch ring or ribs shall be designed for concentrated loads, applied at the points of support of the open spandrel construction. In determining the amount of the concentrated live loads transmitted to such points, the equivalent uniform live load may be used, so placed as to produce maximum stresses at the section under consideration.

In filled spandrel wall construction the equivalent uniform live load may be used for the design of the arch ring, so placed as to produce maximum stresses at the section under consideration. In calculating the maximum stresses due to live load when two, three or more tracks are loaded simultaneously and supported by a section of arch ring between longitudinal expansion joints and the following percentages of the specified live loads shall be used.

For two tracks	90 per cent
For three or more tracks	80 per cent

(c) Impact

The dynamic increment of the live load stresses shall be added to the maximum computed live load stresses. The amount of this impact shall be as follows:

$$I = K \frac{(\quad L \quad)}{(\ L + D\ )} L$$

as provided in Section 180.

Impact shall not be added to stresses produced by longitudinal, wind or centrifugal forces.

(d) Wind Forces

Wind forces need generally not be considered in the design of the arch proper or the spandrel portion of the structure except in special cases of long spans or arches having a large rise with respect to its span.

Wind forces shall be considered in the design of piers and abutments.

In such cases the wind forces to be used shall be in accordance with specifications for steel bridges of the American Railway Engineering Association insofar as applicable.

(e) Tractive Forces

Longitudinal or tractive forces shall be considered only in case of open spandrel construction in the design of arch piers and abutments, in an amount equal to 10 per cent of the live load on the loaded portion of the span, applied at the top of the spandrel deck slab.

(f) Centrifugal Force

Structures located on curves shall be designed for the centrifugal force of the live load, applied at a height of six (6) feet above the top of rail. It

shall be considered as a moving load based on the maximum train speed, and shall be taken equal to a percentage of the live load as provided in the American Railway Engineering Association's Specifications for Steel Bridges.

Unit Stresses

3. The unit stresses to be used in the design of the spandrel portion of the arch structure shall be as provided for corresponding members under the "Design" Section of the General Specifications. These unit stresses shall also be used for the design of the arch ring based on the maximum stresses exclusive of temperature and rib shortening, provided, however, that these unit stresses shall not be exceeded by 25 per cent in analyzing the added stresses caused by temperature and rib shortening.

Exhibit A

SPECIFICATIONS FOR DESIGN OF CONCRETE TRANSMISSION POLES

1. The pole is to be designed for the loads it has to withstand.

2. For sleet loads, a coating of ice ½ inch thick shall be taken making an increase of one inch in the diameter of all wires, cables and hangers.

3. Wind loads shall be taken as eight pounds per square foot on projected areas of ice coated wires, cables and hangers or fifteen pounds per square foot on projected areas of bare wires, cables and hangers. The wind load on poles shall be taken as thirty pounds per square foot of projected area.

4. The range of temperature to be considered shall be taken from the appropriate weather bureau reports.

5. The pole may be circular in cross-section or be polygonal with an even number of sides. It shall have a gradual taper of not less than 1/10 inch per foot on each face or each element if circular in cross-section.

6. The top of the pole shall be not less than six inches in diameter or in distance between parallel faces of polygon.

7. The pole shall be imbedded not less than six feet into a concrete foundation below the surface of the ground, except under special soil conditions.

8. The general theory of reinforced concrete beams and columns shall apply in the design of the pole.

9. The concrete shall have a minimum compressive strength of 3500 lb. per square inch at twenty-eight days. The extreme fibre stress in flexure shall not exceed 1200 lb. per square inch in compression.

10. The ratio of modulus of elasticity of steel to that of concrete shall be taken as ten.

11. The reinforcing steel shall conform to the American Railway Engineering Association specifications for Intermediate Grade of Reinforcement Bars. The allowable working tensile stress shall not exceed 16,000 lb. per square inch.

12. Reinforcement rods shall be uniformly spaced and no steel shall be closer than ¾ inch from the surface of the concrete.

13. With all wires broken on one side and the wires covered with ice, taking wind pressure into consideration, or 2000-lb. unbalanced pull, the allowable unit stresses may be increased 40 per cent.

Appendix C

(3) PROGRESS IN THE SCIENCE AND ART OF CONCRETE MANUFACTURE

L. W. Walter, Chairman, Sub-Committee; Kennerly Bryan, Jr., Hardy Cross, T. L. D. Hadwen, L. V. Haegert, W. K. Hatt, A. C. Irwin, G. M. Johnson, J. A. Lahmer, J. P. Mack, D. A. Ruhl, F. E. Schall, J. H. Titus, C. A. Whipple, P. H. Winchester, J. J. Yates.

The last report of the Sub-Committee, as incorporated in the 1930 report of the Committee on Masonry, embodies a discussion of the factors which are of special concern in the production of concrete of a quality calculated to render satisfactory performance in service. Reference to that report will suggest factors which were then and are now too often neglected in the control of field operations. During the past year, the Sub-Committee has endeavored to maintain contact with various organizations and societies which, through special bureaus or committees, are organized to observe and study the performance of concrete structures in service and to carry on research work, the result of which gives promise of material aid in the solution of problems under study.

In dealing with fundamental requirements for concrete, namely, Strength, Durability and Economy, a study of the factors affecting the durability of concrete is by far the most involved.

The schedule of work as now outlined to deal with factors affecting the durability of concrete follows:

(1) Best method of tests for determining the suitability of fine and coarse aggregates for use in concrete.
(2) Cement-density relation.
(3) Density-durability relation.
(4) The minimum amount of cement per cubic yard of concrete and the maximum amount of water per bag of cement for use in concrete in alkali soils in sea water and in structures exposed to severe weather conditions in freezing climate.
(5) Proper curing and its value as affecting density and durability.
(6) Causes, effects and methods for control of water gain.
(7) Segregation of materials other than water in concrete.

TENTATIVE SPECIFICATIONS AND TEST FOR HIGH EARLY STRENGTH PORTLAND CEMENT

A.S.T.M. DESIGNATION C 74–30 T

The A.S.T.M. Tentative Specifications and Tests for High Early Strength Portland Cement must meet the requirements in the definition for Portland Cement. They are identical in all respects with the present A.S.T.M. Standard Specifications and Tests for Portland Cement with the following exceptions:

1. The maximum allowable sulfuric anhydride (SO_3) is 2.50 per cent as against 2 per cent for standard Portland Cement. Stipulation is made that the sulfuric anhydride content shall be reported as 2.50 per cent when all results are in excess of the specified limit but within the permissible variation of 0.10 per cent.

2. The strength requirement is based on 1 and 3-day tests. The minimum strength requirement in standard briquette test is 275 pounds per square inch after storage in moist air for one day, and 375 pounds per square inch after storage one day in moist air and two days in water. The specifications also contain the following provision:

> "If, at the option of the purchaser, a 28-day test (with storage of one day in moist air and 27 days in water) is required, the average tensile strength obtained at 28 days shall be higher than the strength obtained at three days."

Appendix D

CONTACT WITH JOINT COMMITTEE ON STANDARD SPECIFICATIONS FOR CONCRETE AND REINFORCED CONCRETE

C. P. Richardson, Chairman, Sub-Committee; M. Hirschthal, A. R. Ketterson, J. F. Leonard.

During the past year the Joint Committee has been reorganized and resumed active work on the revision and enlargement of its report of August 14, 1924, published in A.R.E.A. Bulletin 269, dated September, 1924, with the following representatives of this Association as appointed by its Board of Directors:

M. Hirschthal
A. R. Ketterson
J. F. Leonard
J. B. Hunley
C. P. Richardson, Chairman

At its initial meeting of the Joint Committee, held on June 26, the following organization was perfected:

	Executive Committee
Prof. W. A. Slater, Chairman	Prof. W. A. Slater, Chairman
S. C. Hollister, Vice-Chairman	S. C. Hollister
F. R. McMillan, Secretary-Treasurer	C. M. Chapman
	F. R. McMillan
	C. P. Richardson

At its second meeting, held on October 2-3, Rules and By-Laws were adopted and all sub-committees organized to immediately proceed with their assignments.

All members of the Association are requested to submit any suggestions or criticisms of the former Joint Committee Report directly to the Association representatives.

The next meeting of the Committee was scheduled for February, 1931.

Appendix E

(6) WATERPROOFING AND DAMPPROOFING

J. A. Lahmer, Chairman, Sub-Committee; J. T. Andrews, G. E. Boyd, Theo. Doll, L. V. Haegert, A. D. Harvey, C. S. Johnson, C. R. Montgomery, D. A. Ruhl, F. E. Schall, C. P. Schantz, L. W. Skov, J. H. Titus, L. W. Walter, C. A. Whipple, C. C. Williams.

Much of the trouble arising in concrete structures is traceable to water penetrating the structure. It is important for the preservation of concrete that water be excluded from its interior where exposed to freezing temperatures. Even in climates where freezing weather is not encountered contained water can give rise to considerable volume changes within the mass of the concrete and this is multiplied many times in climates where freezing and thawing is encountered.

The various means at present commercially available to protect concrete are: (1) Integral, (2) Plaster Coat, (3) Membrane, (4) Paint Coat, (5) Plastic Coat.

Of these methods the first two, namely, the Integral and the Plaster Coat methods have been longest known. They have been thoroughly tried out and have been either abandoned or are used only where exposure conditions are not severe, and where appearance is not a consideration.

A plain hot mopping of bitumen applied to any masonry structure exposed directly to the elements may not prove satisfactory because it may not stay in place and will not be able successfully to resist local stresses. By incorporating a membrane, preferably an open mesh membrane, within the hot mopped bituminous applications several very important advantages are secured. The functioning of the membrane is purely mechanical and in itself it of course has no waterproofing value. It does, however, perform an extremely valuable function by acting as a retaining and reinforcing grid which holds the bituminous waterproofing material permanently in position and serves also to distribute over a large and varied area any local stresses which may be thrown upon the membrane.

The membrane methods may be roughly classified as felt membranes and cloth membranes; a further subdivision is necessary as to the bitumen used. The bitumen may be either coal tar pitch or asphalt. Of the two available bituments the use of coal tar pitch is steadily decreasing while the use of asphalt is steadily increasing.

In asphalts there exist every conceivable gradation of composition and properties. The consistency varies from that of molasses to that of anthracite coal. The melting point and susceptibility to temperature changes, the cohesion, adhesion, and the ductility of asphalts may be varied by almost imperceptible degrees.

In general for waterproofing purposes it is a safe rule to use the softest asphalt consistent with a high melting point, of a given grade, which can be held in place. This permits securing high chemical stability and the maximum ductility and adhesion thus insuring that the material will remain in place and hence have a long effective service life. The most effective specification for an asphaltic waterproofing material balances the various desirable properties against the disadvantages which any one of these properties in too high a degree would entail.

The use of felt is decreasing while the use of pure cotton fabric is very rapidly increasing. Burlap as a waterproofing membrane has been practically abandoned.

In connection with the type of cloth it is beginning to be considered that a heavy weight is neither necessary nor desirable in a cotton fabric to obtain the necessary strength and it is further considered that an open mesh fabric possesses considerable advantage over the closed mesh type. These advantages reside in the fact that the open mesh permits the escape of air during the operation of laying the fabric into the hot mopped asphalt and in the fact that the overlying and underlying layers of hot mopped asphalt penetrate the open meshes of the fabric thereby forming a continuous blanket of waterproofing asphalt. With the felts and closed mesh cotton fabrics these advantages are not realized. A closed membrane divides the waterproofing blanket into separate layers of bituminous material, each layer functioning separately and being unable to aid or support the bitumen separated from it by the closed membrane.

Although the felt possesses considerable tensile strength it has very little elasticity or ability to resist without rupture any tendency toward elongation; therefore, instead of serving to distribute a local stress it is apt to yield locally to this stress, resulting in a crack corresponding to the masonry crack and extending through the waterproofing blanket. On the other hand the cotton fabric being highly elastic in every direction distributes and absorbs a local stress over a very considerable area on either side of the line where the crack is occurring in the masonry and will tend to prevent a crack forming in the waterproofing blanket.

The cotton-asphalt blanket when properly applied in two or more plies may be so constructed as to resist successfully a reasonable amount of hydrostatic head and this cotton-asphalt membrane should be used wherever high water pressures are to be resisted.

On the other hand, there are many cases where conditions of exposure are much less severe and seldom go beyond the point of exposure to water without pressure or mere exposure to dampness or high humidity. The protection of concrete structures against such comparatively mild conditions is usually referred to as dampproofing in contradistinction to waterproofing to withstand pressure.

In the paint coat method reliance is placed upon the application by brush or spray of a thin surface coating of some protective material. This material may be either penetrative or nonpenetrative. The present day practice seems to incline rather to the nonpenetrative class of material.

The penetrative applications consist mainly of a bitumen or other waterproofing material dissolved in a thin solvent. The theory of this method is that the penetrative solvent will carry the particles of waterproofing material into the pores of the concrete and will there deposit them in such a manner as completely to fill these pores. This theory is decidedly faulty as may be readily seen by visualizing what actually takes place. At the end of the penetrative process the pores are more or less completely filled with solvent carrying only a very little waterproofing agent in solution. The next step is an evaporation of this solvent and when the solvent leaves, the concrete and the pore space formerly occupied by this solvent is necessarily left void. Therefore, the only effective part of a penetrative application is that which

remains on the outer surface and does not penetrate at all. This being the case there would seem to be no reason for attempting to secure penetration and it would seem best to rely from the beginning on a continuous impervious coating which is placed on the outside of the concrete and which will remain in permanent adhesive contact therewith.

The nonpenetrative or partially penetrative paint coating materials may be divided into the two broad classes of cut-backs and emulsified products. The cut-backs consist of suitable coal-tar pitch or asphalt (fluxed if necessary) cut-back or dissolved with a sufficient amount of a suitable solvent to bring the mixture to the proper consistency for application. A combination of hard bitumen and light solvent will give a quick drying material leaving in place a hard, glossy and inelastic film. The more usual combination of a very soft asphalt and a heavy solvent will give a very slow drying application which will remain tacky for months and will eventually leave a coating of soft and very adhesive bitumen. There are innumerable possible combinations between these extremes.

The particular advantages of the cut-back products are their low cost and their ease of application. A poorly prepared cut-back product is very difficult to detect and does not provide adequate protection. Further disadvantages of the cut-back materials are the inflammable nature of the solvents and the toxic character of some of them.

As opposed to the cut-back products the emulsified products contain no solvent. The asphalt or other bitumen exists in the form of minute particles suspended in a non-solvent vehicle which is usually water. An emulsifying agent is always necessary.

The advantages of using emulsified asphalt coating are (1) that it is applied without heating, (2) that it will adhere to damp surfaces better than cut-backs and (3) that it can usually be spread on thicker than cut-backs. Emulsified asphalt must be protected from freezing before application. After it is applied it must be protected from freezing until it sets by the evaporation of the contained water.

Plastic coat dampproofings consist of the same materials used for paint coatings to which have been added varying amounts of fibre or mineral filler for the purpose of thickening them to any consistency up to that required for troweling. The most usual and best filler is asbestos fibre. This stiffer consistency permits application in considerably thicker coats than a mere paint or spray coat and consequently a much thicker film of effective coating is obtained. The advantage of plastic coatings over paint coatings is that owing to their greater thickness they contain a much larger body of protective material.

The specifications for membrane waterproofing which were prepared and tentatively approved by the Masonry Committee in 1928 have been considered this year by representatives of Committee VI, Buildings; Committee VIII, Masonry, and Committee XV, Iron and Steel Structures. Agreement was reached except with reference to types of membrane to be included and some of properties to be prescribed for materials.

Appendix F

(9) METHODS OF REPAIRING DETERIORATED CONCRETE

A. C. Irwin, Chairman, Sub-Committee; G. E. Boyd, Kennerly Bryan, Jr., T. L. Condron, L. V. Haegert, D. A. Ruhl, C. P. Schantz, G. L. Staley, I. F. Stern, J. H. Titus, P. H. Winchester, J. J. Yates.

Repairs to deteriorating or disintegrating concrete should be made not only for the purpose of restoration but also to prevent continuation of the difficulty. Knowledge of the cause or causes of deterioration in each case is therefore necessary before adequate plans and specifications can be drawn.

Deterioration due primarily to overload does not come under the scope of this report but weakening due solely to deterioration may properly be considered.

The immediate cause or causes of much of the deterioration of concrete is freezing of contained water and this condition can often be traced to inadequate drainage. Perfectly dry or slightly moist concrete is little, if any, affected by low temperature with the exception of normal contraction. Cracks produced by contraction only are often more unsightly than serious but disintegration due to the expansive action of frost can be permanently repaired only after removing the conditions responsible for moisture saturation.

Water held by filling material behind or between walls, fed through porous concrete to surfaces exposed to cycles of freezing and thawing, present most favorable conditions for deterioration. Aggregate that break up from cycles of freezing when saturated with water, will disrupt the binding paste and cause disintegration. Renewal of the disintegrated portion with new concrete of better quality will often simply transfer the trouble to another part of the surface unless saturation of it is prevented. Repairs to such surfaces must be accompanied by proper drainage or effective waterproofing or both. Attempts to provide adequate drainage are often failures because of outlets so placed and located that they become plugged up or because of insufficient drainage channels.

Methods of repairing and restoring concrete structures may be grouped under the following main sub-divisions:

(A.) Coatings (not exceeding ¾ inch in thickness)
(B.) Patching (not less than ¾ inch in thickness)
(C.) Encasement (not less than 2 inches in thickness for gunite and 4 inches for concrete cast in forms)

Combinations of these general methods, or one of them alone, may be used in connection with

(D.) Consolidation.

(A.) COATINGS (NOT EXCEEDING ¾ INCH IN THICKNESS)

Paints

(1) The use of paints is more in the nature of a preventative than a restoration. Surface coatings have, however, been used to a certain extent as a repair measure in the case of surface deterioration that has penetrated the body of the concrete by a very small distance. In such cases the deteriorated

concrete is removed and the exposed sound surface covered with a sealing material. In general, this method should be considered only temporary.

Surface coatings are also used to seal the surface of patches or encasements and thus constitute a part of the repair work.

Little information is available about the respective merits of the various paints offered for sealing the surface of concrete. It is felt, however, that none of these can be considered permanent. One of two theories is usually the basis for promotion of paint coatings. The coating is supposed to fill the surface pores or to form a membrane over them. Both of these claims are advanced for many of the coatings offered for sale.

Gunite and Plaster

(2) The successful use of a thin coating of mortar to protect poor concrete depends upon the ability to secure an intimate bond with the old concrete and upon ability of the coating to prevent moisture in quantity from passing through it. If the surface of the old concrete is comparatively sound, a coating of ½ to ¾ inch of gunite, cement plaster or stucco will usually prevent passage of water applied to the surface without pressure.

Several fundamental principles, controlled almost entirely by the skill and experience of the workmen, must be followed. A clean, sound, and roughened surface of concrete must first be obtained and any reinforcement exposed in this operation should be cleaned of rust or scale. The surface to be coated should be nearly saturated with water just prior to application of the coating material. The first coat should be projected against the surface in such a way as to secure intimate contact with the surface and fill all depressions in it immediately on application. Over troweling of the first coat usually "drags" the material and pulls it from the depressions, thus preventing adhesion of the material through its ability to grip the protuberance in the hardening process.

Material for hand patching may well be allowed to stand for an hour or more after mixing before applying. This reduces the shrinkage and tendency to craze. The "retempering" can be continued up to any period such that the mortar can be reworked to a plastic consistency. This period of time will depend on the cement, temperature and ratio of water to cement.

In all cases the coating should be given moist curing in order that bond and strength may be developed in the coating.

Failure to fully carry out the above fundamentals will result in spalling off of the plaster coating. Faithful observance of them in the repair of surface deterioration due to ordinary weathering, may be effective at minimum expense. However, such work should not be attempted unless positive assurance can be had that it will be properly done.

(B) PATCHING (Not Less than ¾ Inch in Thickness)

Successful repairs to concrete surfaces made by patching depend upon observance of the same fundamentals that govern the application of cement mortar coatings. They are:

1. Removal of all loose material, all rust or scale from any exposed reinforcement and exposure of sound concrete.
2. Cleaning and roughening the surface.
3. Saturation of the old surface with water just prior to patching.

4. Use of sufficient reinforcement propeily placed.
5. Application of the first coat of patching material with force. There must be no air or dust film between the patch and the old surface.
6. No disturbance of the applied material of the first coat unless that disturbance will provide a more intimate contact.
7. Curing the patch.

The necessity of these requirements is apparent. The patch must have sound material to which to adhere. The surface of the old concrete should be rough to provide numerous protuberances that will be gripped when the patching material contracts in the process of hardening. The concrete to be patched must be saturated with water so that contained water in the new material will not be absorbed by the old concrete, thus robbing the patching material of water necessary for the attainment of strength and consequently preventing bond at the very place where it is most essential. The first coat of the patching material should be applied with force (compressed air or throwing) so as to cause it to fill all the depressions and completely surround the protuberance of the old surface. Attempts to work in the first coat by troweling often result in "dragging" and impaired bond. The intimate contact of gunite applied to old concrete is one of the chief reasons for successful use of cement guns in repairing concrete. If a paint coat of neat cement grout is used previous to application of the patching material, it must be applied immediately before the patching material. A film of dry cement prevents rather than promotes bond.

Moist curing of a patch should be continuously carried out for a period of 10 days. The patch should be protected from the direct rays of the sun. Burlap covering or tarpulins to prevent evaporation of the moisture should accompany application of water at sufficient intervals to prevent the surface from becoming dry. The hardening process stops when the concrete dries out.

Patches should not be feather edged, but rather the boundaries of the patch should be cut square or undercut. Thin feather edges will usually flake off and contribute to deterioration of the entire patch.

Reinforcement of patches is usually but not always advisable. If the patching extends over a relatively large area and varies in thickness between ¾ inch and 1½ inches, reinforcement had best be omitted. It is difficult to hold reinforcement to correct position in thin patches and the use of dowels for that purpose is excessively expensive. Reinforcement too close to the surface is subject to corrosion with consequent expansion and thus promotes rather than prevents deterioration.

In patches of considerable thickness, and particularly if they are to contribute strength, reinforcement should be used. Wire mesh or bars securely fastened to dowels are recommended. The dowels may consist of expansion bolts or anchor bolts and should provide for a more positive fastening of the reinforcement than the simple wiring required merely to hold it in place during concreting. A positive fastening is obtained by providing threaded ends of bolts and two nuts between which the reinforcement may be clamped, or by other effective means such as hooked or U-bolts. Reinforcement should be not closer to the surface than 1 inch and should preferably have not less than 2 inches clear embedment.

Ordinarily, patching with cement guns is superior to hand patching because of the automatic limitation of the water content and forcible application of the material, but hand patching should be satisfactory if conscientiously done by experienced workmen.

Where patching is quite deep and extensive, successful results can be obtained by setting up forms and ramming a low water ratio concrete into them. The ramming in this case supplies the pressure necessary for intimate contact of the new with the hardened concrete. All the other fundamentals above listed should be observed.

(C.) ENCASEMENT (Not Less than 2 Inches in Thickness for Gunite and 4 Inches for Concrete Cast in Forms)

Encasement of an entire structure or part of a structure is resorted to only when deterioration is general. Where deterioration is general, the cause will usually be found in a combination of lean mixes, excess water, no curing and, in many cases, unsound aggregates—all subjected to severe conditions of water saturation and cycles of freezing and thawing or the action of acids or alkalis. If the encasement is to be permanent, these conditions must be corrected.

In general, the mix should have a water ratio not in excess of 6 gallons per sack of cement; the consistency must be such that, whatever the conditions encountered in placement, the encasing concrete should be given moist curing for at least 10 days—and this means continuously for that time. There should be no question about the soundness of the aggregates.

Preparation of the surface for encasement is much the same as for patching.

Encasement will usually strengthen the structure if anchored to it in a positive manner and provided with reinforcement.

An old structure will, of course, have acquired practically all of its volume change due to shrinkage in hardening. When this old structure is enclosed in new concrete, the latter will undergo shrinkage on removal of moist curing and grip the old structure in a way somewhat analogous to an embedded reinforcement bar.

Reinforcement of encasing concrete should be proportioned and positioned to minimize and distribute cracking due to shrinkage. It should be placed near the outside face but not closer than 2 inches to it if the encasement is 5 inches or more in thickness. In other than round or continuously curved structures the reinforcement should be increased in amount at the corners.

In order to prevent appreciable shrinkage stresses until the concrete has hardened sufficiently to develop bond on the old concrete and the reinforcement as well as to acquire a definite modulus of elasticity, the encasement should have continuous curing for as long a period as practicable, but not less than 10 days.

The encasement must be so designed and constructed as to prevent moisture saturation of the old concrete behind the encasement unless the climate and thickness of encasement are such as to prevent freezing at the old surface. This often means that the encasement must be carried over the top of the old structure as well as around it. If there is any doubt as to the

efficiency of the top concrete encasement in preventing water from penetrating between the old and new concrete, some form of effective waterproofing should be applied over the top surface. Bad drainage conditions should always be greatly improved or completely cured.

Encasement for the purpose of increasing the original strength as well as restoring the structure usually requires a special design to determine the amount, location and anchorage of reinforcement in order to assure integral action of the new and old parts.

(D.) Consolidation

Consolidation of old concrete by internal grouting holds much promise in making repairs to defective concrete permanent. Excessive porosity, leaky laitance joints and cracks, as well as internal and surface honeycombing have been successfully sealed by this method. If the mass can be completely plugged by internal grouting the structure itself will be proof against percolation of water, and treatment of exposed surfaces to protect poor aggregate and weak paste can be made effective without recource to expensive drainage improvement or waterproofing.

In general, internal grouting has been done by boring holes at laitance fill planes, leaky cracks or porus areas and forcing grout into the bass of the concrete. Compressed air has been extensively used to push and carry the grout into the interior void spaces. Special apparatus has been developed and patented for this purpose. Successful sealing of structures subjected to considerable water pressure has been accomplished by this consolidation process. Its success in stopping deterioration lies in prevention of water saturation of the concrete by the most direct means, namely, making the concrete itself watertight.

REPORT OF COMMITTEE IV—RAIL

EARL STIMSON, *Chairman;*
A. F. BLAESS, *Vice-Chairman;*
LEM ADAMS,
J. E. ARMSTRONG,
W. J. BACKES,
J. B. BAKER,
F. L. C. BOND,
N. J. BOUGHTON,
C. B. BRONSON,
E. E. CHAPMAN,
W. C. CUSHING,
C. T. DIKE,
W. A. DUFF,
J. M. FARRIN,
L. C. FRITCH,
F. M. GRAHAM,
E. A. HADLEY,
C. R. HARDING,
G. W. HARRIS,
B. HERMAN,
L. J. HUGHES,
C. W. JOHNS,
H. C. MANN,
HUNTER MCDONALD,
R. MONTFORT,
J. V. NEUBERT,
A. W. NEWTON,
R. L. PEARSON,
W. H. PENFIELD,
G. J. RAY,
A. N. REECE,
R. T. SCHOLES,
G. E. TEBBETTS,
J. R. WATT,
J. E. WILLOUGHBY,
W. P. WILTSEE,
LOUIS YAGER,
J. B. YOUNG,

Committee.

To the American Railway Engineering Association:

Your Committee respectfully presents herewith reports on the subjects assigned, as follows:

(1) Revision of Manual (Appendix A, Exhibits A to D incl.).

(2) Details of mill practice and manufacture as they affect rail quality and rail failures, giving special attention to transverse fissure failures, collaborating with the Rail Manufacturers' Technical Committee (Appendices B and C).

(3) Compilation of statistics of all rail failures, making special study of transverse fissure failures (Appendices D and E).

(4) Cause and prevention of rail battering, collaborating with Committee V—Track (Appendix F, Exhibits A, B and C).

(5) Economic value of different sizes of rail. (Committee reports progress).

(6) Specifications for spring washers, collaborating with Committee V—Track. (Committee reports progress).

(7) Compilation of information of tests of alloy and heat-treated carbon steel rails, collecting from railways records of such tests (Appendix G, Exhibits A and B).

(8) Branding of tee rails, with a view toward standardization, collaborating with Committee V—Track (Appendix A, Exhibits E and F).

Action Recommended

(1) That revisions of Form 402-C and 402-E as shown in Appendix A, Exhibits A and C, be approved and substituted for present Form 402-C and 402-E in the Manual.

(2) That new Form 402-C(a) and 402-E(a) shown in Appendix A, Exhibits B and D, be approved for inclusion in the Manual.

(3) That present Form 402-F be discontinued.

(4) That recommendations in Appendix A and Exhibits E and F, covering branding and stamping practice be approved for inclusion in the Manual.

Bulletin 333, January, 1931.

A

(5) That the remainder of Appendix A relating to Form 402-A, Definition of Number 2 Rail and Specifications for Intermediate Manganese Steel Rail be received as information.

(6) That recommendations in Appendix A, regarding Design of Track Bolts be approved for adoption and printing in the Manual.

(7) That reports in Appendices B and C be received as information.

(8) That reports in Appendices D and E be received as information.

(9) That report in Appendix F, Exhibits A, B and C, be received as information.

(10) That report in Appendix G, Exhibits A and B, be received as information.

Respectfully submitted,

THE COMMITTEE ON RAIL,

EARL STIMSON, *Chairman.*

Appendix A

(1) REVISION OF MANUAL

A. F. Blaess, Chairman, Sub-Committee; W. J. Backes, C. B. Bronson, L. C. Fritch, E. A. Hadley, G. W. Harris, R. Montfort, R. L. Pearson, W. H. Penfield, G. J. Ray, W. C. Barnes.

Form 402 A—Report of Rail Failure in Main Track (see Manual, pages 180-181).

The changes proposed in Forms 402 C and 402 E drew the attention of the Committee to this form, and it was found there are three different styles of this form in general use by railroad members of the Association. Committee recommends that the question of drawing up one form that might be found acceptable to all railroads be assigned to it for investigation and report during the ensuing year.

Form 402 C—Rail Failures for Year Ending .... (see Manual, pages 186-187).

Present form is of a very unwieldy size for filing and certain changes are desirable in the data called for on form, among these being a change in the termination of the report year from October 31st to December 31st, and the addition of a column to show failures found by the Detector car. It also seems desirable to have the instructions for filling in the form printed separately.

Copies of proposed revised form 402 C and of the proposed new instruction form 402 C (a) are attached hereto, and Sub-Committee recommends their adoption. (See Exhibits A and B).

Form 402 E—Statement of Transverse Fissure Rail Failures (see Manual, page 185).

Some ambiguity arises in connection with mill designation under this form, also a column should be added for failures found by the Detector car. It also seems desirable to have the report year end on December 31st instead of January 31st, as at present, to agree with the report year recommended for Form 402 C, also to have the instructions for filling in this form printed separately.

Copies of proposed revised form 402 E and of the proposed new instruction form 402 E (a) are attached hereto and Committee recommends their adoption (see Exhibits C and D).

Form 402 F—Manufacturing Record of Transverse Fissure Rail Heats (see Proceedings, Vol. 24, 1923, page 991.

This form no longer serves any useful purpose and has been omitted from the Manual, but through oversight the question was not submitted to the Convention for formal approval. The Committee recommends discontinuance of this form.

Revision of Definition of No. 2 Rails—The Committee recommends that the present definition be retained.

Preparation of Specifications for Intermediate Manganese Steel Rail

The Committee recommends that the suggested specifications shown in the Committee report of March, 1930 (see Bulletin 324, page 1471,, be retained and no modification be made therein until further experience with this material indicates definite changes or additions needed.

Design of Track Bolts

Attention is called to Supplement to the Manual of 1929, Bulletin 329, July, 1930, page 17, which corrects certain typographical errors appearing in the Design for Track Bolts adopted last year and appearing in Bulletin 324, February, 1930 and in Volume 31, Proceedings for 1930, page 1463.

The Committee recommends that Note 3 to Table 3—"Square and Hexagonal Nuts for Track Bolts" be changed from "The recessed type of nut shall have a recess of 1/8 inch" to read "The recessed type of nut shall have a recess of 1/8 inch minimum and 3/16 inch maximum"; to agree with like revision since made in the American Standards Association designs.

(8) BRANDING OF TEE RAILS, WITH A VIEW TOWARD STANDARDIZATION

Branding—Exhibit E attached shows typical branding with data to be given and order of arrangement.

Stamping—Exhibit E shows typical stamping recommended, and Exhibit F shows complete list and design of letters and numerals.

The Manufacturers' Committee, through its Chairman, F. W. Wood, has agreed to conform to the stamping and branding practice here recommended, provided same are approved by the American Railway Engineering Association.

It is expected that the mills will change their branding practice to conform to the recommended practice only at such times as new rolls are made, or old rolls are redressed, but that they will change their stamping practice to conform to the recommended practice as soon as practicable after being notified that the recommended practice has the approval of the Association.

Exhibit A

AMERICAN RAILWAY ASSOCIATION
DIVISION IV—ENGINEERING

FORM 402-C
REV 1931

SHEET NO. OF

RAIL FAILURES FOR YEAR ENDING DECEMBER 31, 19 .. RAILWAY

MILL & KIND OF STEEL	SPEC. CARBON MIN. & MAX.	YEAR ROLLED & YEAR LAID	SECTION & LBS PER YD.	TONS NEW RAIL LAID	EQUIV. TRACK MILES	MILE-YEARS	PERIOD	NUMBER OF FAILURES: BROKEN			HEAD			WEB			BASE			TOTAL			FAILURES PER 100 TRACK MILES PER YEAR IN SERVICE	TOTAL FAILURES DETECTED
								A	B	TOTAL	A	B	TOTAL	A	B	TOTAL	A	B	TOTAL	A	B	TOTAL		
							THIS YR TOTAL																	
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IN FILLING OUT THIS FORM, FOLLOW INSTRUCTIONS ON FORM 402-C(a)
THIS FORM, WHEN FILLED OUT, SHOULD BE RETURNED TO THE AMERICAN RAILWAY ASSOCIATION, 59 EAST VAN BUREN STREET, CHICAGO, ILL.

Exhibit B
Form 402-C(a)
Issued 1931

AMERICAN RAILWAY ASSOCIATION

DIVISION IV—ENGINEERING

Instructions for Filling in Rail Failure Form 402-C

1. Statistics are desired for all new rail weighing 80 lbs. per yard and over laid in all main track. Include rail rolled during the last 6 years only. Continue records for 6 years unless rail has disappeared from main tracks where originally laid. Omit information for rolling of less than 500 tons.
2. Do not include in this report rails broken or injured by wrecks, broken wheels or similar causes, friction burned or battered end rails and those replaced on account of wear.
3. Fill in the information for rollings in which there were no failures as well as for those in which there were failures.
4. Report all Rail Failures, whether detected by Testing Cars or other devices or disclosed by inspection or by actual breakage in service, in the proper columns under general heading "Number of Failures." Report number of rail failures detected by test cars or other testing devices in column headed "Total Failures Detected."
5. Express the tonnage of rails and the mile years in whole numbers, the mileage in whole numbers and hundredths and the failures per 100 track miles in whole numbers and tenths.
6. Under "Kind of Steel" indicate Open-Hearth by "OH," Intermediate Manganese by "IM" or "MM," Heat-treated by "HT." For other special steels assign suitable abbreviations and if not obvious, indicate meanings by footnote.
7. It is important that the report indicate clearly the mill at which the rails were rolled. A list of mills which have rolled rails during the last 6 years is here given together with the corresponding designations which should be entered under "Mill."

Name of Company	*Name of Mill*	*Location*	*Designation*
Algoma Steel Co.	Algoma	Sault Ste. Marie, Ont. Can.	Alg.
Bethlehem Steel Co.	Lackawanna	Lackawanna, New York	Lack.
Bethlehem Steel Co.	Maryland	Sparrows Point, Maryland	Md.
Bethlehem Steel Co.	Steelton	Steelton, Pa.	Stltn.
Carnegie Steel Co.	Edgar Thomson	Braddock, Pa.	Carn.
Colorado Fuel & Iron Co.	Minnequa	Pueblo, Colo.	Colo.
Dominion Iron & Steel Co.	Dominion	Sydney, Nova Scotia	Dom.
Illinois Steel Co.	Gary	Gary, Ind.	Gary
Inland Steel Co.	Inland	Indiana Harbor, Ind.	Inld.
Tennessee Coal, Iron & R. R. Co.	Ensley	Ensley, Ala.	Tenn.
		Germany	Germ.

8. In the first four columns which call for two entries for each item, enter "Mill," "Minimum Carbon," "Year Rolled" and "Section" on first line (opposite "This Year") and "Kind of Steel," "Maximum Carbon," "Year Laid" and "Lbs. per Yd." on second line (opposite "Total").
9. Under "Number of Failures" the sub-column headings "A" and "B" indicate the letter stamped on the rail. The "Total" column, however, should include "A" and "B" rails and all lower rails from the ingot. Enter transverse and compound fissures under "Broken" and horizontal fissures or horizontal split heads under "Head" failures.
10. To convert tons into track miles, the number of tons may be divided by the figures given below, which show the tons (2,240 lbs.) of rail per mile of single track for different weights per yard of rail.

80-lb.	125.71 tons	120-lb.	188.57 tons
90-lb.	141.43 tons	125-lb.	196.43 tons
100-lb.	157.14 tons	130-lb.	204.29 tons
105-lb.	165.00 tons	140-lb.	220.00 tons
110-lb.	172.86 tons	150-lb.	235.71 tons

11. Each line for the different year's rollings should be completely filled in without the use of ditto marks.
12. Report only the failures for the year ending December 31st opposite the lines "This Year" and all failures from date laid to December 31st opposite the lines "Total."
13. In the column "Mile Years" there should be entered opposite the line "This Year" the actual quantity in miles of rail in service for the individual year. Opposite "Total"

the quantity should be the summation of the miles in service for each year from date of rolling. These amounts constitute the divisors for reducing the corresponding number of failures to a 100 mile-year basis, instead of the quantity in miles originally laid, which was used as the divisor up to the year 1922.

14. For Purposes of Reporting Service of Rails:
Rail laid in any month in the year that report is made is considered to have zero years age, hence zero mile years of service.
Rail laid in any month in the year preceding the year of the report shall be considered as having one year's service.
Similarly for rail laid in preceding years.

FOR EXAMPLE:

Assume 30 miles of rail rolled in calendar year 1927 of which
10 miles are laid in calendar year 1927 and
20 miles are laid in calendar year 1928.
None of this rail removed from track prior to 1930.

The reports for succeeding years would show service of these rails as follows:

Date of Report	*Year Rolled*	*Year Laid*	*Equiv. Track Mile*	*Mile Years*	*Period*
Dec. 31, 1927	1927	1927	10	(0 (0	This Year Total to Date
Dec. 31, 1928	1927	1927	10	(10 (10	This Year Total to Date
	1927	1928	20	(0 (0	This Year Total to Date
Dec. 31, 1929	1927	1927	10	(10 (20	This Year Total to Date
	1927	1928	20	(20 (20	This Year Total to Date

15. In case of doubt as to the interpretation of Form 402-C or of any of these instructions, write to the Engineer of Tests, Rail Committee, American Railway Association, 59 East Van Buren Street, Chicago, Ill.

Exhibit C

AMERICAN RAILWAY ASSOCIATION

FORM 402-[illegible]
REV [illegible]

DIVISION IV—ENGINEERING

SHEET NO __OF____

STATEMENT OF TRANSVERSE FISSURE RAIL FAILURES

FROM__________19___TO________19____ RAILWAY________________________

RAIL											FAILURE			
KIND OF STEEL	LBS PER YD.	SECTION	MILL	ROLLED		HEAT NUMBER	LETTER	INGOT NO	LAID		FAILED		NO	DETECTED
				MO	YEAR				MO.	YEAR	MO.	YEAR		

HOW MANY MAIN TRACK MILES ARE IN THE TERRITORY IN WHICH YOU REPORT FISSURE FAILURES?________

IS THIS THE SAME TERRITORY AS THAT IN WHICH YOU REPORT GENERAL RAIL FAILURES ON FORM 402-C?_______

IN FILLING OUT THIS FORM, FOLLOW INSTRUCTIONS ON FORM 402-E(a)
THIS FORM, WHEN FILLED OUT, SHOULD BE RETURNED TO THE AMERICAN RAILWAY ASSOCIATION, 59 EAST VAN BUREN STREET, CHICAGO, ILL.

Exhibit D
Form 402-E(a)
Issued 1931

AMERICAN RAILWAY ASSOCIATION

DIVISION IV—ENGINEERING

Instructions for Filling in Transverse Fissure Rail Failure Form 402-E

1. Report is desired on all transverse fissure rail failures in rail weighing 80 lb. per yard and over, laid in all main tracks. Compound fissures and horizontal fissures (horizontal split-heads) are not to be reported.
2. The report year ends on December 31. Statement of transverse fissure rail failures will be made quarterly, listing the rails that have failed during the quarters ending March 31, June 30, September 30 and December 31.
3. Under "Rail" enter information from brand on rail except that under "Mill," the following mill designations should be used to make identification positive.

Name of Company	*Name of Mill*	*Location*	*Designation*
Algoma Steel Co.	Algoma	Sault Ste. Marie, Ont. Can.	Alg.
Bethlehem Steel Co.	Lackawanna	Lackawanna, New York	Lack.
Bethlehem Steel Co.	Maryland	Sparrows Point, Maryland	Md.
Bethlehem Steel Co.	Steelton	Steelton, Pa.	Stltn.
Bethlehem Steel Co.	Saucon	So. Bethlehem, Pa.	Sauc.
Bethlehem Steel Co.	Cambria	Johnstown, Pa.	Camb.
Carnegie Steel Co.	Edgar Thomson	Braddock, Pa.	Carn.
Colorado Fuel & Iron Co.	Minnequa	Pueblo, Colo.	Colo.
Dominion Iron & Steel Co.	Dominion	Sydney, Nova Scotia	Dom.
Illinois Steel Co.	Gary	Gary, Ind.	Gary
Illinois Steel Co.	South Works	So. Chicago, Ill.	SoWk.
Inland Steel Co.	Inland	Indiana Harbor, Ind.	Inld.
Lackawanna Iron & Steel Co.	Scranton	Scranton, Pa.	Scrn.
Tennessee Coal, Iron & R. R. Co.	Ensley	Ensley, Ala.	Tenn.
		Germany	Germ.

4. Under "Failure" in column headed "No." give the consecutive failure number from the same heat.
5. Report all transverse fissure rail failures whether detected by test cars or other testing devices or disclosed by inspection or by actual breakage in service. For identification, place a star in the failure column headed "Detected" opposite each transverse fissure rail failure detected by test cars or other testing devices.
6. Should any railroad furnishing this report not consent to its publication, notice to that effect should be given on sheet 1, of the form.
7. Include in this report all transverse fissure rail failures with as much of the information as may be available; not omitting the report nor any failure because part of the information is not available.
8. Double space all entries and make each complete without use of ditto marks.
9. Answers to questions appearing at bottom of Form 402-E need be answered on first sheet only of each quarter's report.
10. In case of doubt as to the interpretation of Form 402-E, or of any of these instructions, write to the Engineer of Tests, Rail Committee, American Railway Association, 59 East Van Buren Street, Chicago, Ill.

Exhibit E

TYPICAL BRAND

SHOWING RECOMMENDED DATA & ORDER OF ARRANGEMENT.

Design of letters & numerals optional with manufacturer.

11025	-	R.E.	O. H.	INLAND	1930	IIIIIII
(Weight & Sec. No.)		(Type)	(Kind of Steel)	(Manufacturer & Mill)	(Year Rolled)	(Month Rolled)

TYPICAL STAMPING

SHOWING RECOMMENDED DATA, ARRANGEMENT THEREOF, AND DESIGN OF LETTERS & NUMERALS TO BE USED.

(See next page for complete list of letters & numerals)

EXAMPLE 1

6 3 3 4 5	E	17
(Heat number)	(Rail letter)	(Ingot No.)

EXAMPLE 2

4 9 0 2 1	A	5

Exhibit F

RECOMMENDED DESIGN OF LETTERS AND NUMERALS TO BE USED IN STAMPING

FULL SIZE

ABCDEFG

HIJKLMN

0123456

7890MM OR IM

Appendix B

(2) MILL PRACTICE

Earl Stimson, Chairman, Sub-Committee; A. F. Blaess, C. B. Bronson, E. E. Chapman, W. C. Cushing, E. A. Hadley, J. V. Neubert, G. J. Ray, Louis Yager, W. C. Barnes.

In its report for last year the Committee referred to a plan for carrying on research work for the purpose of developing the cause of transverse fissure failures as well as other defects in steel rails and finding a remedy which will insure better steel.

This plan was described in some detail by the Chairman when presenting the report.

The Committee is pleased to report that the appropriations have been made and the necessary arrangements are now in progress to start the work. It is expected that the Committee will be able to make a progress report at the coming meeting of the Association.

This work is being financed jointly by the American Railway Association and the Rail Manufacturers and will be conducted under the joint supervision of the Rail Committee and the Rail Manufacturers Technical Committee.

Appendix C

(2) OPERATING RESULTS OF THE A.R.A. RAIL FISSURE DETECTOR CAR

By W. C. Barnes, Engineer of Tests, Rail Committee

The reader is referred to previous Rail Committee Reports for the history of the development of the A.R.A. Detector Car and for discussion of its efficiency in locating defects of various types in rail in track.

The car was placed in leasing service on November 15, 1928, and up to the date of this writing (October 22, 1930) it has not been idle a single day except for occasional shopping and for shipping from road to road. The car is now operating under its 35th lease.

Up to October 1, 1930, it had tested a total of 6509 track miles in 417 testing days or at an average rate of 15.6 track miles per testing day.

A total of 1682 defective rails were located, classified as follows: 567 Transverse or Compound Fissures, 345 Horizontal Fissures (horizontal split heads), 378 split heads and 392 miscellaneous made up of broken bases, split webs, broken rails, pipes, etc. The horizontal fissure total is incomplete.

The average number of miles tested per one transverse or compound fissured rail was therefore 11.5 and per defective rail of all types, 3.9. The average number of transverse or compound fissures located per day was 1.36.

The general condition of rail in track cannot, however, be gaged by the general averages here presented nor by averages determined for roads individually for the reason that the majority of fissures are found in rail from certain heats of steel which are particularly susceptible to this type of failure and as rails from given heats are generally laid more or less contiguously the fissured rails from bad heats will be found in specific locations. It is not at all uncommon to test for days without recording a single fissure

and then to run over a short stretch of track where as many as 10 per day are found. It can readily be appreciated that the average obtained for any road depends largely on whether or not such bad locations are included in the territory tested. The rates will also depend upon whether the roads test their track continuously from point to point or restrict their testing to their probable worst sections determined from record of past failures.

The highest record on any road, which was on selected track, was 3.7 miles per transverse or compound fissure. The average of 1972 miles tested on 9 selected roads was 5.48 miles as compared with the average of all roads of 11.5.

The greatest number of fissured rails detected per mile, has not been found on roads having the heaviest traffic but on those using rails from mills which our statistics show produce the greatest number of fissured rails.

Attention is called to the Transverse Fissure Statistics in Appendix E, Figure 1, and explanation in the text regarding effect upon actual future failures in track of the present use of the Detector Cars.

The writer wishes to acknowledge the willing and highly efficient work of the Detector Car Operator, Mr. Henry W. Keevil, who is largely responsible for the fine record that the A.R.A. Detector Car has made.

Appendix D

(3) RAIL FAILURE STATISTICS FOR 1929

By W. C. Barnes, Engineer of Tests, Rail Committee

The Rail Failure statistics for the year ending October 31, 1929, appearing in this report, have been compiled in accordance with the standard method of basing the failure rate on mile years of service in track.

The reported tonnages and track miles of rollings for 1924 and succeeding years embodied in these statistics are as follows:

Year Rolled	*Tons*	*Track Miles*
1924	1,405,977	8,817
1925	1,658,793	10,277
1926	1,842,042	11,165
1927	1,695,999	9,951
1928	1,643,947	9,519
Total	8,246,758	49,729

Table 1 shows the average failures per 100 track miles of rail in service, which occurred in one to five years service of all rail reported, from all mills together with results taken from previous reports which include both Bessemer and open-hearth rail. The 1924 rollings, whose period of observation is now concluded, show an average failure rate of 110.7 per 100 track miles, which is practically the same as that for the 1922 rollings, but an appreciable improvement over the 114.1 rate of the 1923 rollings. The four year record of the 1925 rollings forecasts a lower 5 year rate for the 1925 than for the 1924 rollings.

Fig. 1 shows diagrammatically the five year averages from Table 1.

Table 2 presents a summary from 17 annual reports showing track miles of rail originally laid and total failures in addition to the failures per 100 average track miles of rail in service for periods of one to five years.

Table 3 gives the failure rates of rails from each of the mills for rollings since 1908, for one to five year service periods.

Fig. 2 shows diagrammatically the data from Table 3.

Table 4 presents a recapitulation of the performances, during the five year period, of rails rolled at each of the mills with the exception of Dominion which is omitted because of lack of representation in rollings in all of the years during the period. In this Table the original track miles laid of the various rollings are given for information, the failure rates being computed from the average track miles in service during the period.

Fig. 3 presents diagrammatically the average "Per Year" failure rates per 100 average track miles in service of the 1924 to 1928 rollings from the various mills from Table 4. These rates do not take into consideration the traffic carried. Colorado ranks first with the lowest failure rate of 5.9 with Inland a close second with 6.6, followed by Gary with 10.8. The remaining mills with the exception of Tennessee whose rate of 43.4 is more than double the failure rate of other mills, vary within the fairly narrow limits of 14.7 and 19.7.

Fig. 4, which is presented as information only, rates the performance of the mills from the same data that underlie Figure 3 except that relative traffic density factors have been introduced into the final computations. From the annual freight gross ton miles per mile of main track of each reporting road applied to its track mile years of rail of each of the 1924 to 1928 rollings from any given mill, the weighted average traffic over all of that mill's rail which was reported on, was determined. In like manner the weighted average traffic over all rail from each of the other mills was separately determined. The mill whose rail was subjected to the lightest traffic was then considered to have unit traffic density and relative traffic density factors were determined for each of the other mills, which were applied to the failure rates of the respective mill outputs given in Fig. 3.

No claim is made that this method of rating is entirely accurate but it does give more consideration to the work which the rails from the various mills were called upon to perform than does the method of rating underlying Fig. 3 which takes no account of traffic.

The use of traffic density factors has resulted as follows:

Inland displaces Colorado in first position with the lowest rate of failure with Carnegie second and Colorado a close third. Tennessee remains in the lowest position immediately preceded by Algoma.

Fig. 5 presents diagrammatically the "Total" failure rates by mills and by year rolled from Table 4.

Table 5 shows the average weights of rail from the various mills and from all mills. The all mill averages reported for the years 1924 to 1928 have increased from 101.4 pounds to 109.8 pounds per yard.

Table 1—Average Failures per 100 Track Miles—All Mills

Year Rolled	YEARS SERVICE 1	2	3	4	5
1908					398.1
1909				224.1	277.8
1910			124.0	152.7	198.5
1911		77.0	104.4	133.3	176.3
1912	28.9	32.1	49.3	78.9	107.1
1913	12.5	25.8	44.8	69.5	91.9
1914	8.2	19.8	32.9	50.9	74.0
1915	8.9	19.0	34.2	53.0	82.4
1916	11.8	29.2	47.7	70.6	105.4
1917	21.6	38.9	66.0	110.5	137.0
1918	8.9	27.6	54.0	92.8	125.4
1919	14.8	39.4	73.7	104.8	115.7
1920	14.2	32.4	63.1	84.5	119.6
1921	10.9	34.9	56.9	70.9	98.9
1922	15.9	34.8	55.2	80.4	110.0
1923	14.3	33.2	57.6	86.0	114.1
1924	14.0	33.4	58.3	82.0	110.7
1925	15.5	36.6	58.3	76.6	
1926	17.1	41.2	64.6		
1927	18.4	37.7			
1928	11.0				

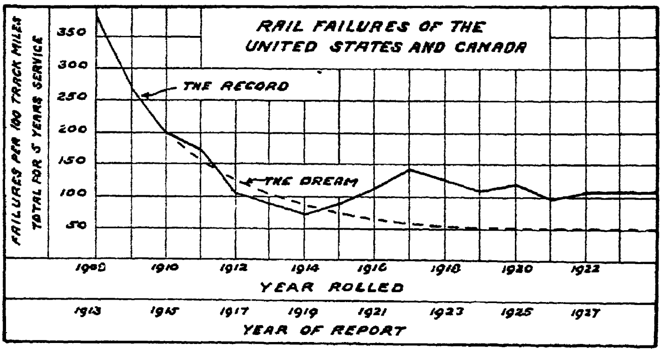


Fig. 1.

Table 2—Summary from Seventeen Years Reports Showing Track Miles Originally Laid, Total Failures and Failures per 100 Average Track Miles in Service

Service	Five Years			Four Years			Three Years			Two Years			One Year		
	Trk Mls of Rail Laid	Failures Total	Failures Per 100 Trk Mls	Trk Mls of Rail Laid	Failures Total	Failures Per 100 Trk Mls	Trk Mls of Rail Laid	Failures Total	Failures Per 100 Trk Mls	Trk Mls of Rail Laid	Failures Total	Failures Per 100 Trk Mls	Trk Mls of Rail Laid	Failures Total	Failures Per 100 Trk Mls
From 1913 Report															
Year Rolled Totals	3001.33	1908 12746	[illegible]	6240.54	1909 14008	224.1	9850.28	1910 12837	104.0	6836.36	1911 5003	77.0	7105.74	1912 2050	28.9
From 1914 Report															
Year Rolled Totals	6697.39	1909 18606	277.8	[illegible]724.85	1910 15009	150.7	6336.48	1911 6364	104.4	7810.60	1912 2401	30.1	8775.44	1913 1395	12.5
From 1915 Report															
Year Rolled Totals	11597.43	1910 22951	195.6	7360.75	1911 10636	123.5	10074.18	1912 5119	49.5	10000.89	1913 1701	25.8	7061.04	1914 564	8.2
From 1916 Report															
Year Rolled Totals	7969.41	1911 14052	176.3	10260.93	1912 8100	78.9	11335.41	1913 5076	44.8	7505.64	1914 1463	19.5	7062.09	1915 656	8.9
From 1917 Report															
Year Rolled Totals	10778.08	1912 11546	107.1	12526.60	1913 8706	69.5	7513.73	1914 2576	30.9	7344.22	1915 1222	19.0	[illegible]	1916 1034	11.8
From 1918 Report															
Year Rolled Totals	11893.57	1913 10924	91.9	7752.27	1914 3948	50.9	7070.02	1915 2414	34.0	2247.44	1916 [illegible]	39.2	7004.06	1917 1596	21.6
From 1919 Report															
Year Rolled Totals	7917.26	1914 5855	74.0	7260.51	1915 3860	53.0	8407.55	1916 4013	47.7	7615.46	1917 2360	30.3	6354.44	1918 566	8.9
From 1920 Report															
Year Rolled Totals	7346.50	1915 6057	82.4	6282.10	1916 5591	73.6	7334.40	1917 4844	66.0	6605.00	1918 1807	27.6	6676.60	1919 986	14.8
From 1921 Report															
Year Rolled Totals	7823.14	1916 8148	106.4	7025.25	1917 7766	110.5	6213.98	1918 3414	54.0	6071.60	1919 2477	39.4	7541.71	1920 1044	14.2
From 1922 Report															
Year Rolled Totals	6945.43	1917 9533	137.0	6117.33	1918 5681	92.0	6408.42	1919 4719	73.7	7250.62	1920 2448	34.4	7421.19	1921 [illegible]	10.0
From 1923 Report															
Year Rolled Totals	5756.11	1918 7221	125.4	6356.57	1919 6097	104.8	[illegible]	1920 4046	63.2	7376.52	1921 2508	34.9	7116.15	1922 1135	15.9
From 1924 Report															
Year Rolled Totals	5913.56	1919 6546	115.7	7271.00	1920 6146	84.5	6857.55	1921 3905	56.9	6374.35	1922 2429	34.8	9501.36	1923 1363	14.3
From 1925 Report															
Year Rolled Totals	6576.46	1920 7759	119.6	6640.46	1921 4950	70.9	6765.99	1922 3514	56.2	8632.16	1923 2731	33.0	7804.76	1924 1098	14.0
From 1926 Report															
Year Rolled Totals	7686.27	1921 7376	98.9	7110.14	1922 5594	80.4	9737.02	1923 5454	57.6	9371.40	1924 3130	33.4	10838.62	1925 1701	16.5
From 1927 Report															
Year Rolled Totals	6997.42	1922 7542	110.0	9657.09	1923 7809	86.0	9056.17	1924 5024	58.3	10844.83	1925 2620	36.6	10250.46	1926 1742	17.1
From 1928 Report															
Year Rolled Totals	8106.36	1923 9253	114.1	7916.99	1924 6493	82.0	9159.06	1925 5342	58.3	9286.90	1926 [illegible]	41.[illegible]	[illegible]527.64	1927 [illegible]	16.4
From 1929 Report															
Year Rolled Totals	6617.34	1924 [illegible]201	110.7	12276.68	1925 7672	76.6	11164.54	1926 6345	64.6	9951.44	1927 3875	37.7	9816.92	1928 1027	11.0

Table 3—Failures per 100 Track Miles in 1908 to 1928 Rollings in One to Five Year Service Periods by Mills

Years Service	YEAR ROLLED																						
	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	192
ALGOMA																							
1					124.0		19.0	7.1	22.7	2.0		7.5	2.6	4.6	17.4	30.3	18.5	2.3	1.2	21.1	6.7		
2				213.7			43.2	11.8	48.1	2.0		26.6	16.5	13.4	51.7	74.[illegible]	48.9	7.9	7.8	45.0			
3			431.0				67.1	22.9	65.4	9.1		55.8	41.0	27.0	83.0	115.8	86.7	30.3	16.8				
4		203.7					67.3	39.1	96.8	29.7		62.9	278.5	42.4	125.5	161.5	151.5	59.6					
5	482.9		12.8				321.4	64.0	159.0	62.9		35.7	472.0	65.2	184.4	276.3	226.2						
[illegible] - (Carnegie)																							
1					12.5	8.9	5.5	1.8	4.7	6.1	6.2	8.5	7.0	3.3	[illegible]	4.1	10.6	17.1	17.2	11.2	10.5		
2				71.5	50.0	19.4	11.9	6.6	13.2	19.5	41.6	35.7	15.1	8.6	20.4	13.9	32.8	41.9	30.9	23.4			
3			38.9	108.9	55.3	32.8	16.6	26.3	26.8	59.5	50.2	36.5	24.4	22.6	38.0	26.0	48.4	57.0	50.9				
4		104.1	112.9	125.1	78.4	62.7	25.4	29.2	46.6	72.5	72.7	40.5	59.4	27.5	48.7	40.9	63.0	74.5					
5		137.1	191.1	165.6	99.6	60.0	48.8	45.7	69.7	92.2	126.5	60.5	87.6	52.6	65.5	58.2	79.3						
CAMBRIA - (Bethlehem)																							
1					17.1	26.7	15.8	6.2	7.2	22.9	32.9	22.3	27.6	13.6	15.1	12.6							
2				73.7	41.6	49.5	37.7	19.5	25.9	36.9	95.5	75.2	44.2	42.2	42.3	36.9							
3			38.5	122.1	74.3	78.3	51.9	24.1	35.7	112.9	248.0	62.6	96.8	101.2	62.0	53.3							
4		244.8	136.4	227.7	106.3	106.2	64.3	56.7	77.7	211.6	369.7	103.[illegible]	158.5	155.8	74.0	97.2							
5		326.6	201.0	157.2	140.9	122.1	137.7	111.5	157.6	334.2	507.4	152.7	143.1	137.4	126.0	123.5							
DOMINION																							
1												5.7		60.9				2.6	1.3	6.3	5.3		
2											60.0	102.3						2.6	5.6	14.2			
3											149.0	186.9						2.7	14.0				
4											420.3	298.3						7.1					
5											482.7	396.0											
ENSLEY - (Tennessee)																							
1					7.3	2.7	7.5	[illegible]	15.6	17.[illegible]	10.4	14.1	39.9	37.5	44.7	42.4	32.6	35.5	34.6	48.4	12.6		
2				14.9	32.9	16.5	16.6	15.0	27.1	35.7	34.6	34.2	83.1	64.9	106.7	130.4	62.4	90.1	89.9	115.6			
3			32.4	45.[illegible]	43.9	14.6	20.0	30.6	61.1	68.2	79.9	100.7	149.3	149.7	170.0	136.2	126.4	160.3	160.5				
4		11.1	47.6	40.2	14.5	41.6	44.2	[illegible]	82.2	102.5	142.1	132.3	189.6	184.7	204.7	194.5	161.5	168.7					
5	86.5	82.7	55.2	61.7	13.2	57.2	60.8	70.9	123.4	109.5	146.3	71.7	222.4	231.6	264.9	145.3	249.6						
GARY - (Illinois) includes So. Works to 1910 inclusive.																							
1					7.4	10.0	11.0	13.7	11.1	9.1	2.5	11.5	5.4	4.2	5.0	6.6	5.4	5.6	8.2	11.8	12.0		
2				67.5	22.2	21.9	30.0	21.9	25.0	19.9	10.8	26.8	13.3	16.2	11.[illegible]	17.[illegible]	10.9	10.3	22.9	20.4			
3			[illegible].4	34.0	73.2	44.0	47.2	40.9	42.0	46.3	18.5	43.7	36.9	27.0	20.6	32.5	18.8	20.3	42.7				
4		151.9	126.8	107.7	64.6	52.1	57.6	55.1	70.7	75.5	46.4	77.1	55.6	41.7	20.4	51.1	25.2	34.5					
5		219.7	200.2	178.6	100.0	41.5	36.[illegible]	75.8	97.2	107.7	50.3	107.1	64.2	58.9	42.0	72.9	44.4						
INLAND																							
1																7.6	2.6	5.6	10.7	2.5	4.6		
2															13.0	12.8	6.7	10.4	10.7	7.8			
3															35.7	20.4	16.7	21.8	20.8				
4															52.1	29.5	22.2	30.1					
5															75.7	33.4	38.2						
LACKAWANNA - (Bethlehem)																							
1					4.6	7.[illegible]	1.6	13.2	6.9	16.6	7.4	[illegible].8	14.5	3.6	4.0	11.6	10.5	16.7	14.0	37.1	6.6		
2				59.6	20.1	21.4	10.0	12.8	25.5	31.6	22.7	51.3	27.1	19.0	13.6	35.9	29.3	36.0	41.9	22.0			
3			4[illegible].7	57.1	39.6	51.3	24.5	38.1	40.1	46.6	43.8	77.4	50.6	41.3	22.6	57.6	60.6	53.9	50.3				
4		100.1	30.3	106.6	67.1	74.0	43.3	57.5	58.0	78.3	65.5	86.7	74.1	62.4	36.6	90.8	59.5	86.8					
5	143.5	117.8	148.9	1[illegible]	88.6	115.3	73.7	73.1	76.9	104.5	33.2	165.0	99.0	83.2	49.9	106.6	97.2						
MARYLAND - (Bethlehem)																							
1					11.7	26.6	13.3	14.5	30.7	160.6	27.7	24.2	0.0	0.0				11.1	31.0	62.1	20.2		
2				32.0	5.8	74.1	25.2	60.2	61.8	214.2	53.2	52.8	2.3	7.2			1.5	62.6	72.3	53.5			
3			69.6	49.5	18.1	88.4	2[illegible].4	37.6	32.6	360.5	117.6	60.8	11.9	25.3			6.0	61.9	53.2				
4			104.8	56.5	6.6	117.0	56.2	138.1	36.6	415.5	159.1	30.8	11.0				35.4	55.9					
5			162.7	67.4	110.8	159.7	62.9	231.4	180.5	445.5	210.5	106.9				180.0	65.4						
MINNEQUA - (Colorado)																							
1					16.3	3.3	3.7	4.6	5.5	5.4	6.6	5.0	9.2	9.2	12.0	7.0	4.3	3.6	[illegible].8	[illegible].1	3.8		
2				15.8	40.9	11.0	7.6	7.7	15.7	12.5	13.1	19.5	27.6	31.7	27.1	29.3	9.6	7.2	8.9	4.6			
3			19.6	21.0	35.6	26.0	14.1	17.1	34.[illegible]	30.7	50.7	32.9	75.0	50.6	58.9	54.3	28.7	19.1	20.0				
4		22.4	23.4	52.[illegible]	31.3	46.6	27.5	34.4	53.6	51.5	109.0	66.2	96.6	72.7	111.6	91.5	39.2	32.0					
5	45.5	23.2	60.9	84.5	117.6	82.1	42.0	80.3	78.1	42.6	154.8	90.2	130.5	97.8	136.6	108.9	57.6						
STEELTON - (Bethlehem)																							
1					5.3	9.6	8.2	6.7	35.6		2.4	46.0	56.3	4.9	10.3	10.0	16.6	7.8	20.2	13.7	21.3		
2				34.6	11.6	21.0	21.1	16.1	46.1		9.2	79.6	38.5	12.8	18.7	16.7	38.9	34.5	41.0	34.4			
3			81.4	79.6	17.6	34.7	23.4	17.9	94.[illegible]		20.7	129.6	73.2	25.9	20.1	21.2	66.5	50.6	64.3				
4		86.3	110.9	119.0	46.8	47.2	76.0	48.4	156.1		50.6	175.1	76.7	41.6	29.7	41.1	80.1	77.5					
5	72.9	101.4	125.8	145.2	60.4	71.2	43.7	53.5	171.7		76.0	275.8	139.5	56.1	43.9	49.4	95.9						
SAUCON - (Bethlehem)																							
1					11.9	13.4	3.8	17.1	17.7	39.0	19.6	31.2	10.5	12.9	36.6								
2				113.3	32.0	20.9	6.9	24.5	42.4	59.2	57.7	72.3	57.6	65.4	77.3								
3			174.0	136.5	62.1	62.6	16.0	41.0	75.2	94.6	78.4	105.0	66.5	88.4	130.6								
4		466.1	246.0	251.7	83.2	77.3	21.6	66.0	110.9	127.7	91.5	160.7	84.5	114.3	177.4								
5	508.7		350.9	329.8	106.3	99.5	33.0	92.4	152.0	157.5	133.7	215.9	95.5	145.5	223.4								
ALL MILLS																							
1					26.3	11.6	6.0	8.8	11.7	21.8	8.9	14.8	14.2	10.8	15.9	14.3	14.0	15.5	17.1	18.4	11.0		
2				55.0	28.9	24.8	18.9	19.0	27.9	58.9	27.6	39.4	32.4	34.9	34.8	33.2	33.4	36.6	41.2	37.7			
3			61.3	85.5	46.0	45.3	30.8	33.8	47.7	66.0	54.0	75.7	65.1	56.9	55.2	57.6	58.3	58.3	64.6				
4		168.6	107.1	111.2	74.2	68.5	47.4	65.0	70.6	110.5	92.8	104.8	84.5	70.9	80.4	86.0	82.0	76.6					
5	370.5	198.5	154.0	161.9	108.7	90.3	74.0	82.4	106.4	137.0	125.4	115.7	119.6	98.9	110.0	114.1	110.7						

Table 4—Recapitulation Totals and Averages Grouped by Mills. Track Miles Represent Quantities Originally Laid. Failures to Date Computed by Mile Years of Rail in Service

Year Rolled	Original Trk. Mls.	Total Failures	Failures to Date Per 100 Av. Trk.Mls. Total	Failures to Date Per 100 Av. Trk.Mls. Per Year	Original Trk. Mls.	Total Failures	Failures to Date Per 100 Av. Trk.Mls. Total	Failures to Date Per 100 Av. Trk.Mls. Per Year
Algoma					Edgar Thomson (Carnegie)			
1924	600.54	1180	176.8	47.1	[illegible].27	748	79.8	18.9
1925	479.15	286	59.6	14.9	1212.66	[illegible]	71.5	16.7
1926	319.26	60	18.8	[illegible]	1497.7[illegible]	754	50.9	17.0
1927	188.97	88	46.0	22.5	1410.[illegible]	328	23.4	11.7
1928	771.73	51	6.7	6.7	1151.[illegible]	118	10.2	10.3
Totals	2260.36	1666	Ave.	18.7	[illegible]	[illegible]	Ave.	14.7
Ensley (Tennessee)					Gary (Illinois)			
1924	1670.43	2394	143.0	49.[illegible]	2210.79	321	44.4	8.9
1925	2050.97	3401	1[illegible].7	[illegible]	2271.48	735	34.5	8.5
1926	2225.20	2211	150.5	50.1	2491.56	992	42.7	14.[illegible]
1927	1415.07	1510	110.6	55.[illegible]	2100.33	477	23.4	10.2
1928	1427.02	175	12.6	12.6	2100.13	240	12.0	12.0
Totals	8994.71	12594	Ave.	4[illegible].4	11241.23	[illegible]	Ave.	10.5
Inland					Lackawanna (Bethlehem)			
1924	643.52	221	36.2	7.6	1032.98	914	37.2	19.4
1925	693.47	195	30.1	7.5	961.47	601	66.6	21.7
1926	773.96	203	30.6	10.2	1122.57	560	50.2	16.6
1927	753.65	57	7.5	3.9	924.42	294	37.0	15.5
1928	709.28	32	4.5	4.6	756.17	65	8.6	5.6
Totals	3601.09	741	Ave.	6.6	4845.44	2034	Ave.	15.9
Maryland (Bethlehem)					Minnequa (Colorado)			
1924	111.58	70	65.4	13.1	787.65	420	57.8	11.5
1925	400.44	216	55.9	14.0	934.43	299	32.0	8.0
1926	360.77	196	53.2	17.7	1122.53	224	20.0	6.7
1927	509.66	263	51.6	26.8	1285.16	59	4.6	2.3
1928	432.19	87	20.2	20.2	1075.17	41	3.8	3.8
Totals	1824.54	832	Ave.	19.7	5146.17	1043	Ave.	5.9
Steelton (Bethlehem)					All Mills			
1924	926.01	880	95.9	19.2	8617.34	9201	110.7	22.1
1925	1039.84	786	77.6	19.4	10163.67	7664	77.4	19.4
1926	1072.38	627	62.3	20.8	11010.30	6908	68.2	21.7
1927	1024.17	762	74.4	17.2	9888.14	3666	37.9	18.9
1928	993.79	211	21.2	21.3	3462.21	1024	11.0	11.0
Totals	5056.19	2777	Ave.	19.[illegible]	43141.76	284[illegible]	Ave.	15.7

Table 5—Average Weights of Rails Compiled from Tonnages Used in this Report

Mill	1924	1925	1926	1927	1928
Algoma	100.5	100.9	100.7	100.3	101.1
Dominion		101.4	101.4	101.4	101.4
Edgar Thomson (Carnegie)	114.3	110.6	114.4	114.6	118.5
Ensley (Tennessee)	95.1	90.9	97.2	98.4	102.5
Gary (Illinois)	98.9	101.1	103.5	107.0	109.8
Inland	97.3	104.5	101.9	104.7	111.1
Lackawanna (Bethlehem)	99.1	99.5	107.7	109.0	109.2
Maryland (Bethlehem)	97.0	98.7	100.6	115.7	114.9
Minnequa (Colorado)	91.5	103.3	95.4	104.6	102.2
Steelton (Bethlehem)	122.1	123.8	123.5	123.6	123.4
All Mills	101.4	102.6	104.9	108.4	109.8

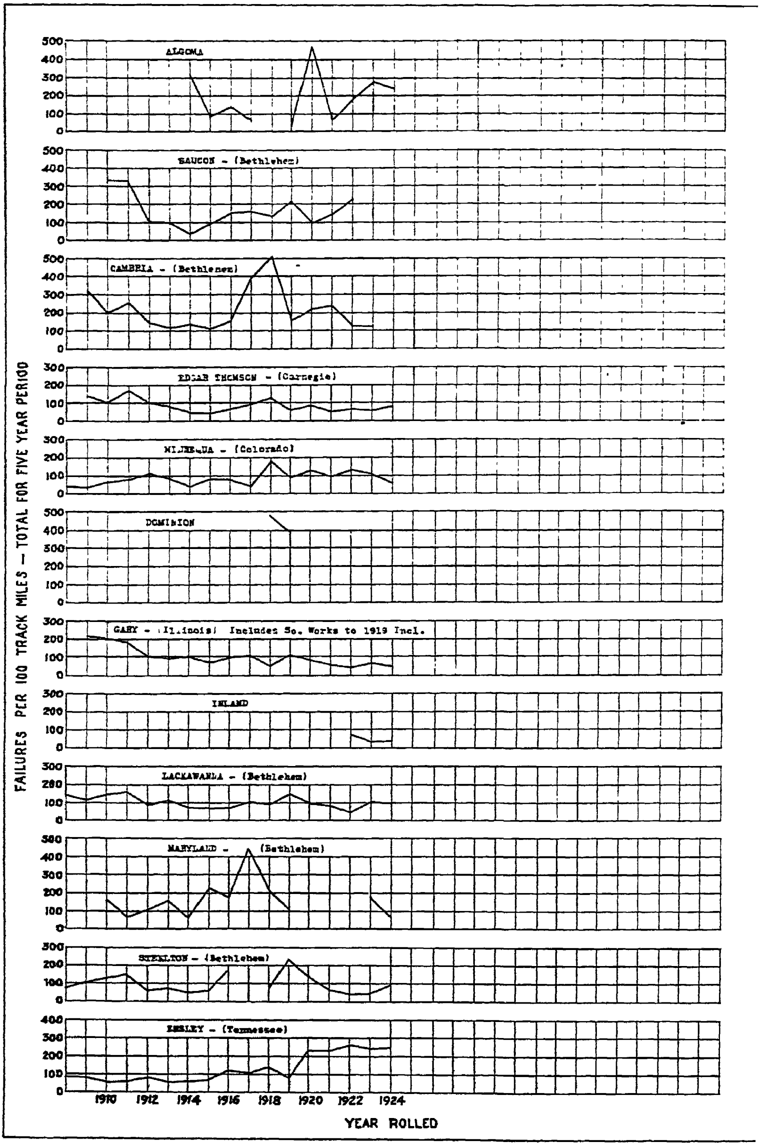


FIG. 2—RECORD OF FAILURES PER 100 TRACK MILES FOR FIVE YEARS' SERVICE FOR ROLLINGS FROM 1908 TO 1924.

Diagram Showing Mill Ratings Compiled by Usual Method

Mill	Failures per 100 Ave. Trk. Mls. per Year
ALGOMA	18.7
EDGAR THOMSON (Carnegie)	14.7
ENSLEY (Tennessee	43.4
GARY (Illinois)	10.8
INLAND	6.6
LACKAWANNA (Bethlehem)	16.9
MARYLAND (Bethlehem)	19.7
MINNEQUA (Colorado)	5.9
STEELTON (Bethlehem)	19.6
ALL MILLS - Average	18.7

FIG. 3—AVERAGE FAILURE RATES FOR THE ROLLINGS OF 1924 TO 1928 INCLUSIVE, CLASSIFIED BY MILLS.

Diagram Showing Mill Ratings as Altered by Use of Traffic Density Factors

MILL	Failures per 100 Ave. Trk. Mls. per Year per Unit of Traffic Density
ALGOMA	18.7
EDGAR THOMSON (Carnegie)	3.8
ENSLEY (Tennessee)	22.7
GARY (Illinois)	4.9
INLAND	2.4
LACKAWANNA (Bethlehem)	7.6
MARYLAND (Bethlehem)	7.0
MINNEQUA (Colorado)	3.9
STEELTON (Bethlehem)	5.2
ALL MILLS - Average	7.6

FIG. 4—THIS DIAGRAM IS PRESENTED AS INFORMATION ONLY. IT SHOWS AVERAGE FAILURE RATES FOR THE ROLLINGS OF 1924 TO 1928 INCLUSIVE, CLASSIFIED BY MILLS, CHANGED FROM THOSE PRESENTED IN FIG. 3.

Diagram Showing Failures per 100 Average Track Miles by Mill and by Year Rolled for Periods Ending October 31, 1929

MILL	Year Rolled	Failures per 100 Average Track Miles
ALGOMA	1924	236.2
	1925	59.6
	1926	18.8
	1927	45.0
	1928	6.7
EDGAR THOMSON (Carnegie)	1924	79.3
	1925	74.8
	1926	50.9
	1927	23.4
	1928	10.3
ENSLEY (Tennessee)	1924	249.6
	1925	168.7
	1926	150.5
	1927	113.6
	1928	12.6
GARY (Illinois)	1924	44.4
	1925	34.5
	1926	42.7
	1927	20.4
	1928	12.0
INLAND	1924	38.2
	1925	30.1
	1926	30.8
	1927	7.8
	1928	4.6
LACKAWANNA (Bethlehem)	1924	97.2
	1925	86.8
	1926	50.3
	1927	33.0
	1928	8.6
MARYLAND (Bethlehem)	1924	65.4
	1925	55.9
	1926	53.2
	1927	53.5
	1928	20.2
MINNEQUA (Colorado)	1924	57.8
	1925	32.0
	1926	20.0
	1927	4.6
	1928	3.8
STEELTON (Bethlehem)	1924	95.9
	1925	77.5
	1926	62.3
	1927	34.4
	1928	21.3
ALL MILLS (Average)	1924	110.7
	1925	77.4
	1926	65.2
	1927	37.9
	1928	11.0

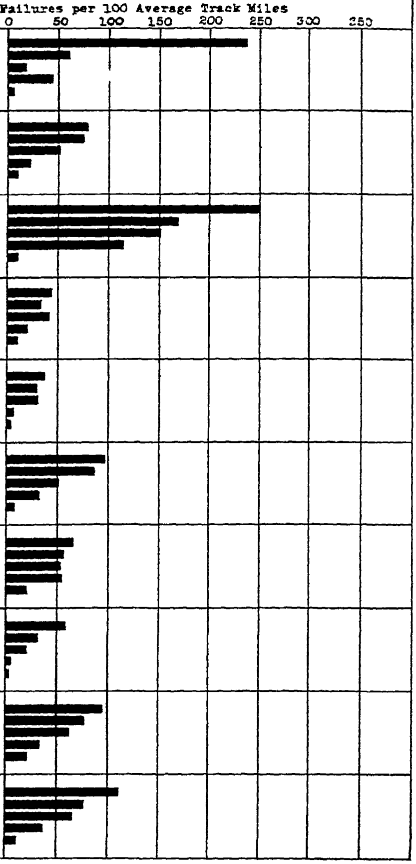


FIG. 5—ACCUMULATED FAILURES FOR ROLLINGS FROM 1924 TO 1928 INCLUSIVE.

Appendix E

(3) TRANSVERSE FISSURE STATISTICS

By W. C. Barnes, Engineer of Tests, Rail Committee

These statistics constitute a cumulative record of 44035 transverse fissure failures that have been reported up to and including January 31, 1930.

Table I corresponds with Table I of last year's report and shows the number of transverse fissure failures reported by each of 54 roads and the years in which such failures occurred.

The accumulated total reported to January 31, 1930, from all rollings was 44035 compared with a total to January 31, 1929, of 37,797 or an addition during the year of 6238 at an average rate of 17 failures per day. This is an increase of 780 over the preceding year's total of 5458. The major part of this increase was due to the inclusion of 478 fissured rails that were detected by improved methods of testing developed on the recommendation of the Rail Committee and removed from track before actual breakage occurred. The removal of these detected fissure rails from track will of course be reflected in a corresponding reduction in total subsequent actual failures in track. Increase in number of fissured rails "detected" is not an indication of greater prevalence of fissures but of greater ability to detect them.

Such detected fissure failures as were reported are included in the fiscal year "1929" and "Grand Total" columns, and also shown separately by roads under column headed "Det. 1929." Many fissured rails were detected during the year on roads which do not report fissure failures to the Association and hence do not appear in Table I.

Fig. 1, shown for the first time, presents graphically the total fissure failures reported each year. The dotted curve includes "detected" fissured rails while the solid curve excludes them. The trend of the solid line in future reports will be of interest. It is to be expected that the increasing number of fissured rails being detected and removed from track before breakage will in a short time cause the solid curve to take a downward slope, indicating a decreasing number of actual failures in track per year instead of the constantly increasing number reported each year to date.

Fig. 1 - Total Fissure Failures Reported each Year

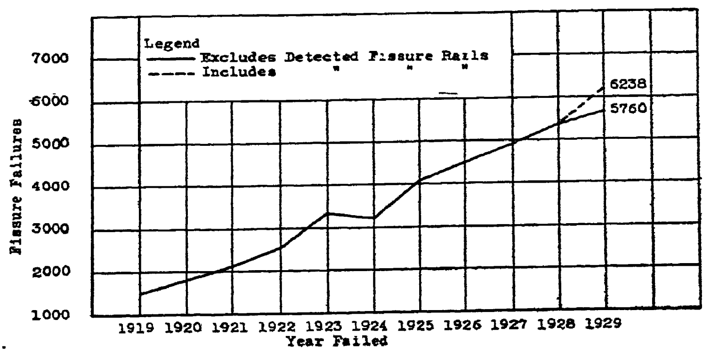


Table 2 corresponds with Table 2 of last year's report with the exception that it includes a total of 478 detected fissure failures and the column designations now indicate specifically the mills where the rails were rolled. This has been accomplished by transferring to the "Unknown" mill columns a small number of failures incorrectly reported by the roads in former reports as Bethlehem rail with mill not designated. It shows all transverse fissure failures accumulated from year rolled to January 31, 1930, for each year's rollings from each mill, unweighted by tonnage out-put of mills, by density of traffic or by years of service.

This table is most useful in comparing the failures in the various rollings from any one mill. The rollings of 1910, 1912, 1913 and 1917 from all mills continue to show the largest number of accumulated failures, due principally to the large number of failures in Illinois Steel Company, Gary rollings, for these years. The rollings which produced the greatest number of failures in

Table 1
Transverse Fissure Failures
by Railroads and Year Failed
(Report Year ends with January 31st of following calendar year)

Railroad	Prior 1919	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	Total	1929	Grand Total	Det.** 1929
A.T. & S.F.	40	25	177	220	134	126	81	79	71	98	126	1177	91	1268	
A.C.L.									11	9	27	47	25	72	
Ban. & Aroos.									11	2	0	13	4	17	
B. & Eastern							0	0	0	0	0	0	0	0	
Boston & Albany	4	17	23	30	25	15	10	9	3	12	8	156	31	187	
Boston & Maine						35	69	72	78	70	44	368	34	402	
B. & O.						212	297	369	253	458	405	1994	481	2475	53
B.R. & P.					9	11	9	16	15	17	26	103	41	144	
Can. Nat.									13	--	--	13	---	13	
Can. Pac.		4		8	16	59	86	158	277	174	160	942	108	1050	
Cent. of Ga.	106	52	23	41	31	29	24	40	20	20	42	428	92	520	
Cen.R.R.of N.J.										34	58	92	95	187	
C. & E.I.									4	--	22	26	69	95	26
C. & O.				6	26	46	49	81	208	104	165	658	186	844	19
C. & N.W.									65	63	47	195	78	273	16
C.B. & Q.		1	7	34	101	87	--	--	--	--	--	230	--	230	
C.M.St.P. & P.	2		6	5	14	11	11	13	5	9	26	102	54	156	43
C.R.I. & P.	10	2	11	25	37	75	73	114	98	97	90	632	143*	775	20
C.C.C. & St.L.					2	1	1	47	21	11	36	119	44	163	
D.L. & W.	474	193	240	169	91	60	73	113	128	86	92	1739	139	1878	
El Paso & S.W.					8	6	(See	Sou.	Pac.)			14		14	
Erie					15	42	89	100	118	148	126	641	262	903	27
Great Northern										58	221	279	175	454	
Hocking Valley					13	53	82	38	2	4	30	222	94	316	3
Illinois Central	11	35	121	130	272	566	419	501	614	656	615	4032	682	4714	25
Indiana Harbor						1	3	3	0	0	0	7	0	7	
Lehigh & Hudson				1		4	4	16	33	10	7	75	8	83	
L. & N.E.						32	0	0	0	0	1	33	0	33	
Lehigh Valley					57	89	112	92	75	75	56	556	60	616	
Long Island				2	8	7	11	2	3	6	--	39	--	39#	
L.A. & S. L.							1	7	12	36	39	95	34	129	2
L. & N.	474	9	17	33	43	77	90	75	141	295	374	1628	557	2185	101
Mich. Cent.						2	5	11	13	10	8	49	15	64	
M.K.T.				2	11	13	17	29	26	32	33	164	40	204	10
Mo. Pac.					2	8	--	--	--	--	--	10	--	10	
Mobile & Ohio									18	30	59	107	22	129	4
N.C. & St. L.	10		1	2	2	8	5	7	3	15	15	68	34	102	
N.Y.C.(East)	415	84	86	93	136	107	126	165	223	257	295	1989	327	2316	27
N.Y.C.(West)			1	18	37	16	31	62	49	44	34	292	54	346	
N.Y.C. & St.L.						2	--	--	--	--	--	2	--	2	
N.Y.N.H. & H.					12	28	26	57	63	34	27	247	68	315	17
N.Y.O. & W.										59	62	121	63	184	
Nor. & Western					3	17	45	29	18	16	18	146	25	171	
Nor. Pacific					42	39	120	161	152	184	166	864	208	1072	48
Pennsylvania	2244	1114	1129	1104	904	649	501	785	868	741	574	10613	584	11197+	
Reading					52	112	107	91	36	42	39	479	53	532	
R.F. & P.									0	0	0	0	4	4	3
Rutland								3	2	1	0	6	2	8	
Sou. Pac.	57	9	6	130	118	143	175	243	335	397	530	2143	500	2643	
Southern Ry.						24	6	13	51	123	191	408	205	613	
Tenn.& N. Cnt.										0	0	0	0	0	
Union Pac.				36	262	557	498	473	356	289	341	2812	438	3250	32
Virginian											10	10	12	22	
Western Md.								65	111	164	212	552	57*	609	
All Roads	3847	1545	1850	2149	2584	3382	3257	4136	4596	4993	5458	37797	6238	44035	478

**Fissured rails detected in 1929 and removed from track prior to breakage. These are also included in Column headed "1929".
* Includes 3[illegible] failures which occurred in January 1929 and were received too late for inclusion in last year's report.
# Long Island failures subsequent to 1927 included with Pennsylvania R.R.
+ First Quarter failures only. Failures in last 3 quarters not reported.

Table 2

Accumulated Transverse Fissure Failures
reported to Jan. 31, 1930 by Year Rolled and by Mill
(Includes fissured rails detected before actual failure in track)

Year	Unknown			Algoma			Saucon (Bethlehem)			Cambria (Bethlehem)			Edgar Thomson (Carnegie)			Minnequa (Colorado)			Dominion			Krupp (German)		
Rolled	Prior	1929	Total	Prior	1929	Total	Prior	1929	Total	Prior	1929	Total	Prior	1929	Total	Prior	1929	Total	Prior	1929	Total	Prior	1929	Total
Unk.	49	9	58	8	0	8	24	3	27	30	5	35	28	5	33	34	1	35	2	0	2			
1889																								
1890																								
1891													1	0	1									
1892										2	0	2												
1893										1	0	1												
1894										6	0	6												
1895										5	0	5	1	0	1									
1896																								
1897										10	0	10	5	0	5									
1898										15	0	15	4	0	4									
1899										14	0	14	7	0	7									
1900										15	0	15	7	0	7									
1901										26	0	26	17	0	17									
1902	2	0	2				2	0	2	61	1	62	34	1	35	1	0	1						
1903										58	0	58	64	0	64									
1904	6	0	6							25	1	26	40	0	40	1	0	1						
1905	2	0	2	4	1	5				27	1	28	34	1	35									
1906							2	0	2	67	0	67	44	0	44				7	1	8			
1907				2	0	2	10	0	10	70	0	70	29	0	29	2	0	2						
1908				4	0	4	208	6	214	14	0	14				1	0	1	61	11	72			
1909				4	1	5	1326	40	1366	75	0	75	28	5	33	3	0	3	8	1	9			
1910	10	0	10	5	3	8	581	63	644	106	2	108	15	1	16	341	19	360						
1911				8	0	8	863	39	902	349	1	350	62	2	64	290	19	309						
1912	6	0	6	6	0	6	125	10	135	555	48	603	51	6	57	59	12	71	53	0	53			
1913	6	0	6	6.	0	6	284	13	297	500	14	514	53	7	60	24	10	34	3	1	4			
1914	2	0	2	24	1	25	143	0	143	313	7	320	27	6	33	51	14	65	5	4	9			
1915	2	0	2	362	59	421	269	14	283	124	3	127	27	9	36	172	8	180						
1916	1	0	1	87	6	93	342	12	354	79	5	84	73	3	76	312	45	357						
1917	2	0	2	6	0	6	239	10	249	130	13	143	57	4	61	249	94	343						
1918	1	1	2	374	5	379	63	16	79	74	4	78	66	4	70	39	20	59	69	2	71			
1919	1	0	1	342	8	350	220	10	230	9	0	9	17	3	20	17	9	26	41	5	46			
1920				76	4	80	61	2	63	58	4	62	71	1	72	129	39	168						
1921	1	0	1	7	3	10	159	11	170	140	7	147	93	7	100	45	18	63	2	0	2			
1922				15	12	27	74	12	86	64	2	66	152	8	160	18	6	24						
1923	96	0	96	32	25	57				39	3	42	81	21	102	23	9	32						
1924	66	0	66	11	17	28							55	37	92	18	5	23						
1925	55	0	55	1	1	2							68	45	113	3	7	10						
1926	22	0	22										127	71	198	3	2	5	0	1	1	1	0	1
1927	22	3	25										54	57	111	0	1	1						
1928	1	0	1	0	1	1							9	13	22									
1929														1	1					1	1			
Totals	353	13	366	1384	147	1531	4995	261	5256	3061	121	3182	1491	324	1815	1835	338	2173	251	27	278	1	0	1

Gary* (Illinois)			Inland (Inland)			Lackawanna** (Bethlehem)			Lorain			Maryland (Bethlehem)			Pennsylvania (Bethlehem)			Ensley (Tennessee)			All Mills		
Prior	1929	Total	Prior	1929	Total	Prior	1929	Total	Prior	1929	Total	Prior	1929	Total	Prior	1929	Total	Prior	1929	Total	Prior	1929	Total
125	20	145	2	0	2	17	3	20				5	5	10	2	5	7	91	16	107	417	72	489
															2	0	2				2	0	2
						2	0	2				0	1	1	5	0	5				7	1	8
						4	0	4							3	0	3				8	0	8
												1	0	1	2	0	2				5	0	5
												3	1	4							4	1	5
												1	0	1	3	0	3				10	0	10
						1	0	1							2	0	2				9	0	9
1	0	1				4	0	4				0	1	1	3	0	3	1	0	1	9	1	10
						9	0	9				1	0	1	7	0	7				32	0	32
						23	1	24				1	1	2	7	1	8				50	3	53
						12	1	13				3	0	3	18	0	18				54	1	55
2	0	2										6	0	6	11	0	11				41	0	41
2	0	2				19	0	19				12	1	13							76	1	77
1	0	1				2	0	2	1	0	1	33	0	33							137	2	139
1	0	1				1	1	2				58	2	60				26	1	27	208	4	212
2	0	2				48	6	54				20	1	21				196	1	197	338	9	347
6	0	6				14	0	14	3	0	3	27	1	28	5	0	5	323	1	324	445	5	450
4	0	4				6	0	6	5	0	5	51	0	51	1	0	1	52	0	52	239	1	240
23	0	23				25	0	25				77	0	77				60	0	60	298	0	298
5	1	6				7	0	7	1	0	1	2	0	2	1	1	2	32	0	32	336	19	355
672	92	764				70	1	71				58	2	60	102	7	109	6	0	6	2352	149	2501
1935	169	2104				157	25	182				105	3	108	112	1	113	128	13	141	3495	299	3794
229	14	243				333	6	339				209	6	215	113	1	114	147	10	157	2593	98	2691
1195	162	1357				798	27	825				162	10	172	64	17	81	99	6	105	3173	298	3471
1223	118	1361				768	53	821	1	0	1	394	26	420	84	12	96	86	14	99	3441	274	3715
299	44	343				680	33	713				130	1	131	110	0	110	176	16	192	1960	126	2086
452	62	514				311	31	342				403	18	421	142	3	145	70	3	73	2334	210	2544
631	80	711				102	7	109				383	28	411	28	1	29	213	18	231	2251	205	2456
1595	252	1847				122	10	132				623	47	670	3	1	4	165	21	186	3181	462	3643
360	82	442				108	11	119				81	9	90	10	2	12	170	57	227	1515	212	1728
761	176	937				57	19	76				37	14	51	89	6	95	285	87	372	1876	337	2213
447	94	541				118	27	145							126	15	141	114	37	151	1200	223	1423
259	91	350	1	0	1	84	36	120							151	44	195	83	27	110	1025	244	1269
93	53	146	121	18	139	85	36	121				3	0	3	32	27	59	211	55	266	869	228	1097
249	121	370	35	19	54	252	120	372				1	0	1	65	24	89	184	76	260	1057	418	1475
108	79	187	25	18	43	67	40	107				2	0	2	110	40	150	183	150	333	645	386	1031
70	75	145	32	22	54	72	97	169				57	30	87	106	47	153	314	227	541	778	551	1329
53	74	127	66	33	99	45	78	123				37	33	76	56	55	111	372	249	621	782	596	1378
75	33	108	0	4	4	27	88	115				61	64	125	29	65	94	219	185	404	487	500	987
1	5	6	0	2	2	8	37	45				15	52	67	21	53	74	3	32	35	58	195	253
	1	1		2	2		18	18					19	19		22	22		42	42		106	106
10889	1898	12787	282	118	400	4459	811	5270	11	0	11	3062	376	3438	1625	450	2075	4098	1354	5452	37797	6238	44035

1929 were those of 1917, 1923, 1925, 1926 and 1927. The failures in 1917 rail were due in large part to Colorado, Gary and Maryland rails and those in the 1923 rollings to Gary, Lackawanna and Tennessee rail, while those for 1925, 1926 and 1927 rollings occurred principally in Tennessee rail although the failures from Carnegie rollings for those years, while not comparatively numerous, were considerably in excess of those from their previous rollings.

Fissure failures reported during the last few years as occurring in the first year of service are as follows:

29	Failures	in	1925	from	1925	Rollings,	All Mills
50	Failures	in	1926	from	1926	Rollings,	All Mills
114	Failures	in	1927	from	1927	Rollings,	All Mills
58	Failures	in	1928	from	1928	Rollings,	All Mills
106	Failures	in	1929	from	1929	Rollings,	All Mills

The increase in first year failures in the 1929 over 1928 rollings was principally due to Lackawanna rails whose totals increased from 8 in the 1928 to 18 in the 1929 rollings and to Tennessee whose total increased from 3 to 42. The 1929 fissure failures in Lackawanna and Tennessee 1929 rails include 1 and 16 failures respectively that were "detected" before actual breakage. No first year failures were "detected" in rails from other mills. The marked improvement in Tennessee rails rolled in 1928 noted in last year's report is not apparent in their 1929 rollings as the "detected" fissures account for only 16 out of the total excess of 39 for that mill.

Table 3 corresponds with Table 3 of last year's report, but differs from it in many respects. The former Mill Rating Table 3 gave the rate of accumulated failures in rail from rollings of 1909 to 1925 inclusive per 10,000 tons of rail whereas this year it gives for the various mills, for the rollings of 1922 to 1926 inclusive, the rates of failure per year from dates rolled to January 31, 1930 per 100 original track miles of rail reported on by 27 selected roads. The new method therefore, changes the basis of rating from tons to track miles years, thus introducing the factor of length of service. The difference in the average severity of traffic on the rails from individual mills is not taken into account in this table.

It is thought that the average rates of failure of the recent 5 years' rollings will be of more general interest than the averages formerly presented, as they are not influenced by excessive failures accumulated in rail that is now so old that it is practically all out of track. Furthermore mill conditions have so changed that the performance of those old rollings is no longer indicative of present practice.

It is proposed next year to keep the 5 years rollings of the same comparative age by dropping the 1922 rollings and adding those of 1927.

Table 3 includes a total of 5300 transverse fissure failures in 32,586 track miles on 27 roads, 358 of which were "detected" during the 1929 report year.

Fig. 2 shows graphically the average rates of failure by mills from Table 3. The Maryland average rate, which is the highest of all mills, was necessarily based on a comparatively small track mileage and was materially affected by a moderate number of "detected" fissures.

Fig. 3 presented as information, shows graphically the average rates of failure for the 1922 to 1926 rollings of the various mills from Table 3 and Fig. 2, modified by the use of relative traffic density factors; the lightest average intensity of traffic, which prevails on Colorado rail, being considered 100

Table 3- Average Transverse Fissure Failure Rates on Selected Roads per 100 Original Track Miles per Year from Year Rolled to 1/31/30, by Mill and Year Rolled.

Year Rolled	E.Thom (Carn)	Ensley (Tenn)	Gary (Ill)	Inl (Inl)	Lack (Beth)	Mary (Beth)	Minn (Colo)	Penn (Beth)	All Mills
1922	3.63	3.95	1.57	9.88	2.13	-	0.54	1.17	2.58
1923	1.65	3.87	3.31	1.86	9.19	-	0.99	1.08	3.28
1924	2.11	5.27	2.45	1.82	2.29	-	0.38	3.28	2.85
1925	2.40	10.02	1.95	1.19	4.40	5.06	0.14	3.58	3.89
1926	5.09	13.12	1.90	2.66	3.88	15.35	0.04	3.36	5.00
Ave	2.84	5.29	2.32	2.94	4.31	7.25	0.37	2.38	3.42

Fig.2 - Average Failure Rates Classified by Mills

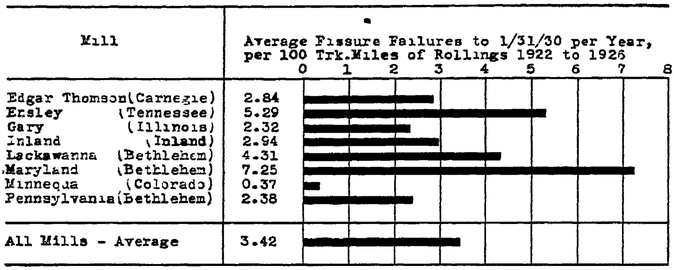
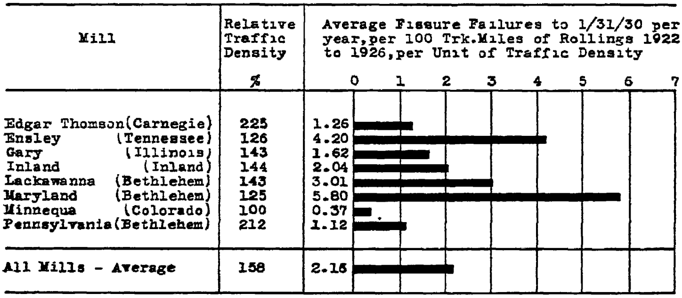


Fig.3- Average Failure Rates by Mills Altered by Traffic Density Factors



per cent. A factor for each reporting road based on its annual gross freight ton miles per mile of main track was applied to the mile years of rail laid on that road from any given mill. The weighted average traffic density for all rail from that mill on all roads was then determined. The relative traffic density on all rails from each of the various mills was then obtained and applied to the failure rate for the respective mills' output as given in Table 3 and Fig. 2.

No claim is made for the entire accuracy of this system of rating, but it does give more consideration to the work which the failed rails from the various mills were called upon to perform than does the system used in Table 3 and Fig. 2 which takes no account of differences in traffic carried.

The weighting for relative traffic density, which is used in this report for the first time, has improved the standing of Carnegie and Pennsylvania with respect to all other mills; of Gary, Inland and Lackawanna with respect to Ensley, Maryland and Colorado; of Ensley and Maryland with respect to Minnequa (Colorado).

Table 4, presented in previous reports, which segregated failures by Mill, Rail Letter and Weight of Section and Table 5 which segregated them by Mill and Month Rolled, have been discontinued as further additions to those tables would serve no useful purpose.

Appendix F

(4) CAUSE AND PREVENTION OF RAIL BATTER

F. M. Graham, Chairman, Sub-Committee; W. J. Backes, N. J. Boughton, W. A. Duff, L. C. Fritch, E. A. Hadley, B. Herman, C. W. Johns, Hunter McDonald, R. Montfort, R. L. Pearson, W. H. Penfield, J. E. Willoughby, W. P. Wiltsee, W. C. Barnes.

The work of this Committee as outlined on page 1493 of the 1930 Proceedings has been carried out with the following results.

(1) Brinell hardness measurements were taken with a portable Brinell meter on the ends of the heads of one hundred and ninety new 130 lb. rails before such rails were placed in track. Subsequent batter measurements during the current year do not show any relation between the Brinell values and the progress of rail batter under very heavy traffic. This result is thought to be due to the necessary inaccuracies in using a portable Brinell meter as varying degrees of hardness in individual rails should affect the rate of rail batter. The Committee knows of no more accurate field method of determining the hardness of rails than was used in this test.

(2) Ninety-five cropped 130 lb. rails were laid in a heavy traffic freight track. Eighteen inches had been cut from the original ends of the rails resulting in a satisfactory joint fit. The relative differences in heights of the two rail ends at any joint did not exceed .060 inches. These differences in heights of rail ends were measured after the rail was laid and before traffic. Batter measurements were taken of the joints seventy-five days after the rail was laid during which time approximately eleven million gross tons of traffic had passed over the joints.

The results of the above measurements are shown on Exhibit A from which the following observations are made:

(a) No appreciable difference in batter is shown regardless of whether the receiving rail is higher or lower than the delivering rail.

(b) The extent of batter on the high rail varies directly with the difference in height of the two rail ends.

(c) The low rail was not battered to any extent until the high rail was battered down to the level of the low rail.

(d) A slight tendency to cupping is shown where the delivering or leaving rail was very high.

(e) No apparent relation exists in this test between the amount of joint opening and the extent of batter, but in all cases there was sufficient opening to permit end flow into the gap.

Similar batter conditions in new rail are observed corresponding to variations in relative heights of rail ends.

(3) One hundred and twenty-three new 130 lb. rails were laid in a freight track with heavy traffic. Eighty-six of these rails were laid in the track in the order in which they passed through the finishing rolls at the rail mill. The remaining rails were also laid in similar order except for eliminating A rails and rejected rails and passing from one ingot to another ingot. Relative differences in rail heights were measured before traffic, giving an average difference in height of .0018 inches in the eighty-six exactly matched rails and .0035 in the balance.

One hundred and ninety days after this rail was laid batter measurements were taken. During this time approximately twenty-eight million gross tons of traffic had passed over this rail.

The results of the above measurements are shown on Exhibit B and it will be observed that:

(a) Regardless of the fact that all traffic had been in the same direction both delivering and receiving rails received practically the same batter.

(b) Fishing fit and height of rail were eliminated in this case as contributing conditions of batter.

(c) Joint gap had no apparent effect on batter, but as with the test shown on Exhibit A, there was sufficient opening to permit end flow into the gap.

Results obtained in the above tests indicated that batter conditions were independent of the direction of traffic and that where the heights of rail ends were the same and with good joint fit the delivering rail was battered equally with the receiving rail. This led to an investigation of the probable unit pressure between the rail and wheel.

For this purpose Exhibit C was prepared containing sheets 1-4 showing the relation between wheel load, radius of wheel, radius of top of rail and resulting unit pressure. This Exhibit was prepared from a discussion shown on pages 21-23 of "Applied Elasticity" by Timoshenko and Lessells. This discussion is based on the assumption that all stresses are within the elastic limit of the material and while this may not be entirely true it may be considered as representing fairly well the conditions in this case.

(4) In order to make rail more resistent to rail batter the Committee is experimenting with the use of local heat treatment on the tops of the ends of rails.

The Committee in collaboration with Committee V—Track, reports progress and recommends the continuation of the study of rail batter along the above and other lines during the coming year, including batter on single track.

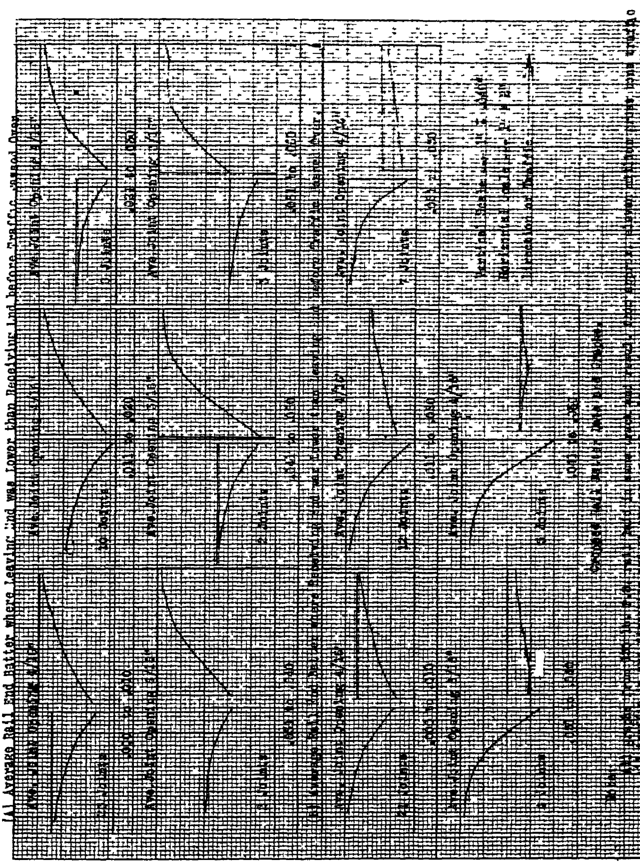
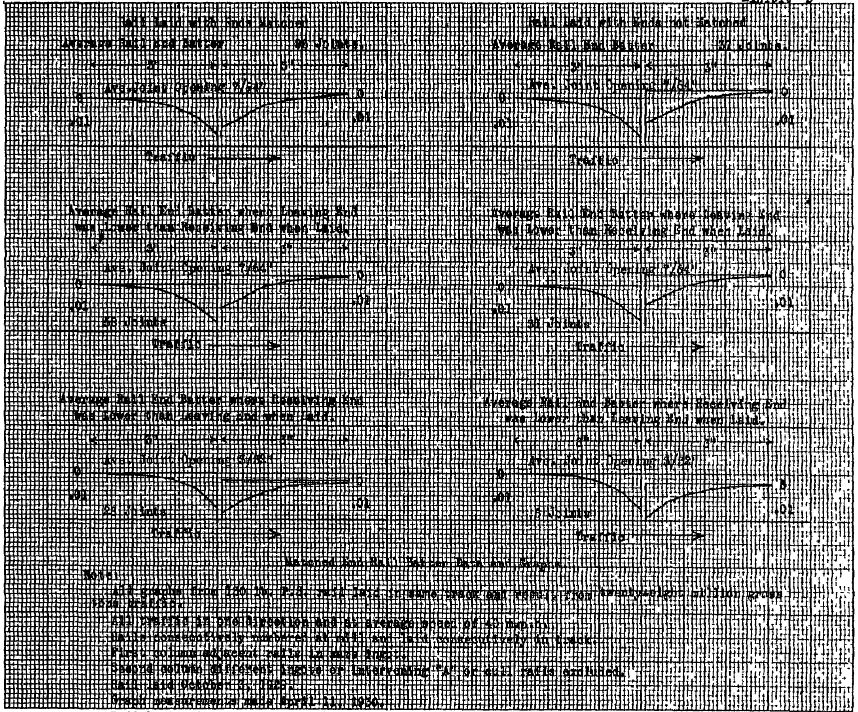


Exhibit 'A'
(A) Average Rail End Batter where Leaving End was Lower than Receiving End before Traffic Passed Over

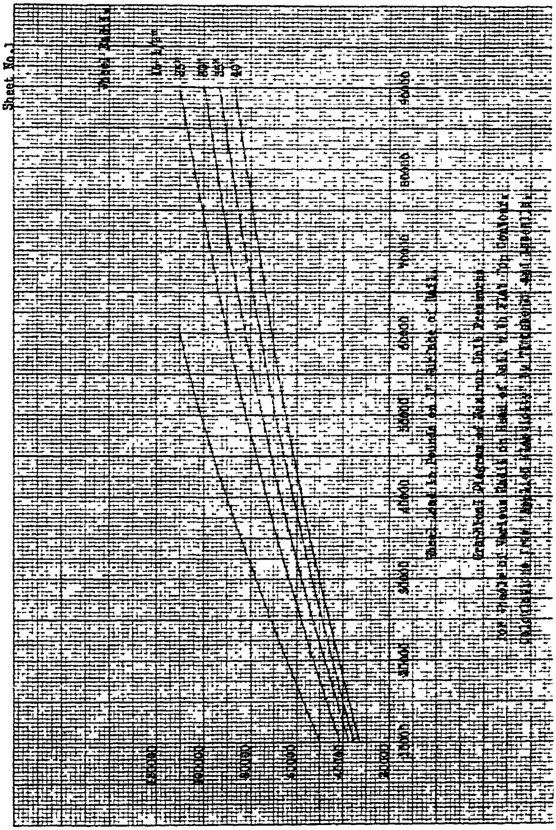
Exhibit 'B'



Rail batter instrument and method of determining batter as adopted by A.R.E.A. Proceedings pages 1271 and 1277.

KEUFFEL & ESSER CO N Y

Exhibit 'O'
Sheet No.1



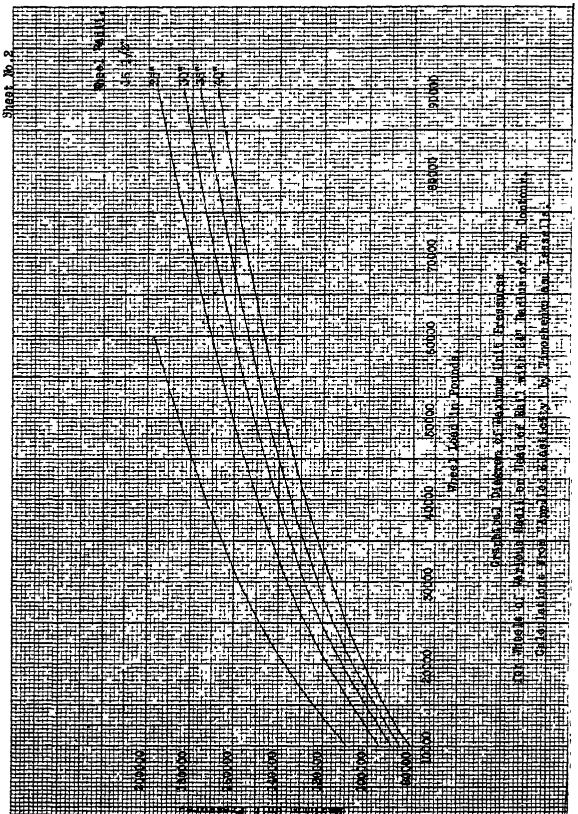


Exhibit 'C'
Sheet No.2
Wheel Radii.
30"
40"
200000
180000
160000
140000
120000
100000
80000
10000
20000
30000
40000
50000
60000
70000
90000
Wheel Load in Pounds.
Graphical Diagram of Maximum Unit Pressures
Calculations From "Applied Elasticity" by Timoshenko and Lessells.

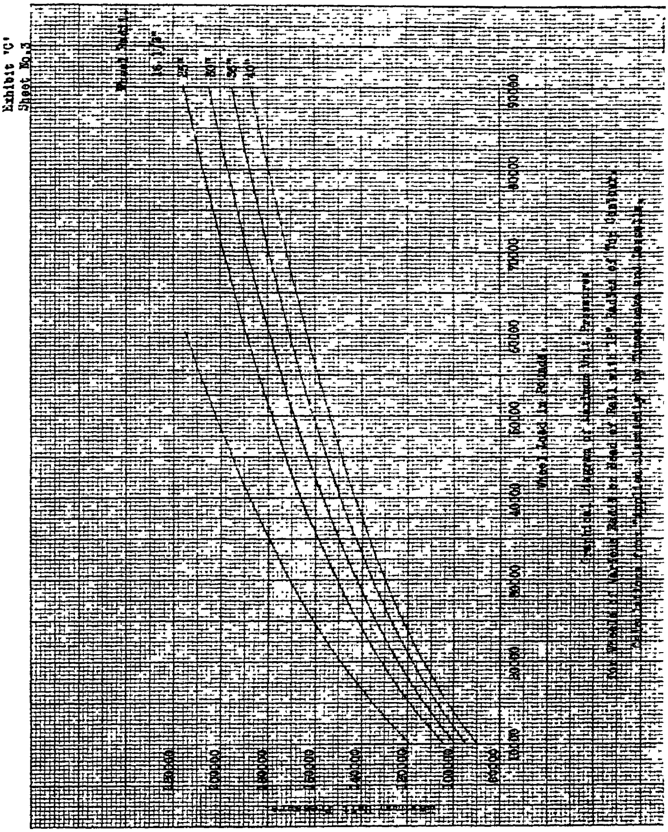


Exhibit 'C'
Sheet No.3
10000
20000
30000
40000
50000
60000
70000
80000
90000
Wheel Load in Pounds

A

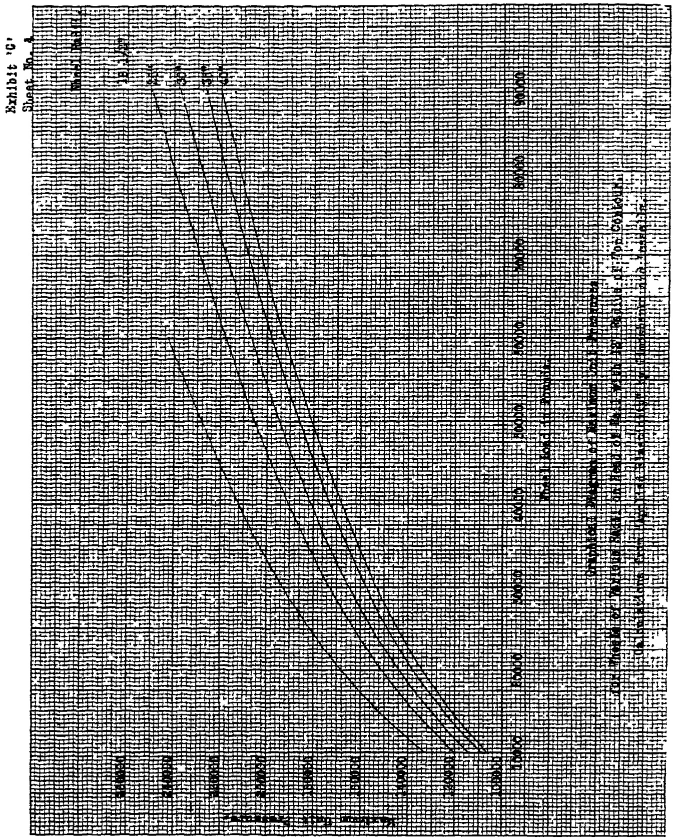


Exhibit 'G'
Sheet No. 4
Wheel Radii.
18 1/2"
25"
30"
33"
40"
260000
240000
220000
200000
180000
160000
140000
120000
100000
10000
20000
30000
40000
50000
60000
70000
80000
90000
Wheel Load in Pounds.

Appendix G

(7) TESTS OF ALLOY AND HEAT TREATED CARBON STEEL RAILS

C. B. Bronson, Chairman, Sub-Committee; J. E. Armstrong, E. E. Chapman. W. A. Duff, C. R. Harding, G. J. Ray, R. T. Scholes, J. B. Young. W. C. Barnes.

Questionnaires were sent to the various railroads to obtain the information and the replies and summaries are shown in the attached reports (Exhibits A and B).

The Committee recommends that this report be received as information.

Exhibit A

ALLOY STEEL RAILS—INTERMEDIATE MANGANESE

More intermediate manganese rails have been purchased during the current year than previously. The total tonnage of this rail in service is now well over 650,000 tons. Several roads have not made any further purchases while others have made material increases in their program.

A questionnaire, as shown below, was sent out to a large number of roads, particularly those with tonnages running into thousands of tons, and those who have had several years experience. The questionnaire was changed considerably from those previously issued, eliminating details as to routine mill inspection matters which are well established by this time. The aim was to get more specific data as to special tests or research work, more information regarding service failures, and measurements pertaining to wear, both on curves and tangent track, and also batter at rail ends, and chipping.

On a number of replies received practically no data was presented along these lines which was largely due to the short time the rails have been in service.

The replies in general are quite favorable to intermediate manganese rails, as the conclusions presented will show. The principal difficulty has been due to a higher rate of horizontal and vertical split heads developing both on curve and tangent track than is generally experienced with standard open hearth rails.

Considerable laboratory work has been done through a number of sources to determine the properties and characteristics of defective rails of this type. The reports generally indicate that the carbon and manganese are quite high, though not segregated to any extent. Some porosity has been noted. One report indicates the presence of martensite; cracks have originated in this hard substance. Thermal checks are quite prevalent, indicating the susceptibility of this steel to thermal conditions during cooling on the hot beds.

Interior transverse fissures are far from numerous and the reports indicate they are much lower than experienced with standard open hearth rails.

Data as to wear, batter and chipping show a considerable reduction as a general proposition compared to standard open hearth rails.

Comprehensive studies which have been made through a number of sources indicate the desirability of lowering the specified carbon range two or three points, and the manganese range five to ten points. By this means, along with complete hot bed protection, horizontal and vertical split heads should be less numerous to a considerable extent. Several roads have changed their specified carbon and manganese ranges in line with the above.

The questionnaire, tables as to purchases and distribution among the mills, and replies are shown below:

PURCHASES OF INTERMEDIATE MANGANESE RAILS

Road	*Reported During 1930*	*Previous to 1930*	*Total*
A. T. & S. F.	45422	23682	69104
Boston & Maine	44942	23314	68256
Canadian Nat'l.	5878	2950	8828
Chesapeake & Ohio	500	......	500
C. B. & Q.	38700	87850	126550
D. L. & W.	14746	85623	100369
Kansas City Sou.	5694	......	5694
Louisville & Nash.		2000	2000
M. K. T.	500	......	500
Northern Pacific		1705	1705
N. Y. C. Lines	89578	148640	238218
Pennsylvania		942	942
Reading		300	300
Illinois Central	5250	......	5250
Southern Pacific	20344	......	20344
Southern Ry.	1710	......	1710
TOTALS	273264	377006	650270

DISTRIBUTION OF INTERMEDIATE MANGANESE RAILS BY MILLS

Company	*Plant*	*Previously Reported*	*Currently Reported*	*Total Tonnage*
Algoma	S. S. Marie	1591	3192	4783
Bethlehem	Lackawanna	78426	47185	125611
Bethlehem	Maryland	......	9742	9742
Bethlehem	Steelton	98811	46228	145039
Carnegie	Edgar Thomson	12247	10877	23124
Colorado		30682	57679	88361
Dominion	Sydney	1459	3882	5341
Illinois	Gary	113005	65813	178818
Inland	Ind. Harbor	38785	21609	60394
Tennessee	Ensley	2000	7087	9057
TOTALS		377006	273264	650270

QUESTIONNAIRE ON INTERMEDIATE MANGANESE RAILS

.... Railroad

1. Tonnage purchased, not previously reported, giving following details:
   COMPANY PLANT WT. PER YD. SECTION TONS
2. Have any changes been made in composition or mill practice for the rails purchased by your railroad during the past year? If so, give details.
3. Give results of any special laboratory tests or investigations on new rails that you may have carried out, either in co-operation with the steel mills or in your laboratory.
4. Present contours or tabulated results of investigations on wear of rail heads on curves and also tangent track, comparing intermediate manganese with standard open hearth rails in similar service.
   What conclusions have you arrived at, based on your general observations of the two classes of steel?
5. Present general or specific data on the batter and chipping of rail ends, comparing intermediate manganese and standard open hearth rails.
6. Table of Intermediate Manganese Rail Failures, summarizing total failures since rail was laid, to August 1, 1930.

Year Rolled	Mill	Section	Tons Rolled	Trans Fissure	Comp Fissure	Horiz. Fissure	Split Head	Crush-ed Head	Web	Base	Total

7. How do intermediate manganese and standard open hearth rail failures compare, giving detailed statement, or general conclusions.
8. Report special tests or investigations on failed or defective intermediate manganese rails, and conclusions derived therefrom.
9. What conclusions, briefly stated, have you arrived at as to the relative merits of intermediate manganese compared to standard open hearth rails.

NOTE: If purchases have been made of special or alloy steel rails other than heat treated, please report on form similar to the above and submit.

2. Have any changes been made in composition or mill practice for the rails purchased by your company during the past year?

No changes are reported except those listed below:

D. L. & W.—The rate of cooling of rails rolled in January, 1930, at Lackawanna Mill, Bethlehem Steel Company, was regulated as follows:

(a) Rails of about 2 heats were placed close together on hot bed at temperature of about 2000°F. as received from the rolls, covered at once and cooled under cover to about 600°F. Rails not turned at any time.

(b) Rails of about 15 heats were placed on hot beds about 12 inches apart and allowed to cool to about 1180°F. when they were turned and covered, and cooled under cover to about 600°F.

(c) Rails of 6 heats placed on hot bed about 12 inches apart and allowed to cool to about 1400°F. when they were turned and covered, and cooled under cover to about 600°F.

(d) Rails of 44 heats placed on hot bed about 12 inches apart and cooled to about 1800°F. when they were covered and cooled to about 600°F. Rails were not turned.

The above hot bed treatments were conducted to see to what extent hair cracks in the interior of the head could be eliminated.

N.Y.C. Lines.—Several experimental lots of rail were made in practically the same manner as described above for the D.L. & W. on both full length rails and pieces about 6 feet long. The full length rails were placed in track and their service is being followed.

In addition to covering rails on the hot beds, the beds were protected by side guards to prevent underdrafts and make the rate of cooling more uniform. In addition sheet metal paving was placed between the hot bed skids. The hot bed building was thoroughly enclosed and complete protection afforded against snow and rain blowing upon the beds.

These steps were taken to retard the rate of cooling as much as possible without delaying mill operations by increasing the time upon the hot beds, as well as to insure as uniform rate of cooling as possible.

In addition a study was made as to the effect of silicon upon piping. Heats were taken up to 0.30 silicon without material increase in pipe rejections. (Our rejections are not on nick and break test but based upon examination of each rail subject to inspection.)

Canadian National:

1929 Purchases

Carbon	0.50 to 0.65
Manganese	1.30 to 1.60
Phosphorus	Not over 0.04
Sulphur	Not over 0.055
Silicon	Not under 0.15

1930 Purchases

Approximately ¼ of purchase having exactly same chemical properties as 1929 specification. Approximately ¼ of purchase having carbon, mang., phos. and sulphur the same as 1929 spec., but silicon not over 0.05. Approximately ½ of purchases having carbon, mang., phos. and sulphur the same as 1929 spec., but silicon from 0.05 to 0.10.

3. Give results of any special laboratory tests or investigations on new rails that you may have carried out, either in co-operation with the steel mills or in your laboratory.

D. L. & W.—In connection with the experimental hot bed work which is described under question 2, several hundred horizontal longitudinal slices were cut at about one half the depth of head, and then lightly and deeply etched. Hair cracks or thermal checks decreased measurably in number and size as the retarding of drop in temperature during cooling was more effective. Specimens buried in ashes were practically free from internal cracks.

Of the rails which were handled by various methods on the hot beds as described in 2, the following defective or failed rails have developed:

One split head from heats that received cooling treatment under scheme (b).

One split head and one half moon base break from heats that received cooling treatment per scheme (c).

Of the 5189 tons of rail rolled in March, 1930, and cooled as per scheme (d), three split heads from one heat and one half moon base break from another heat.

N.Y.C. Lines.—Similar etched specimens in large numbers were examined as referred to by the D. L. & W., and results of a comparable condition found. In addition representative samples were studied under the microscope to see what effect retarded cooling, even that of the longest duration would have upon grain structure. There was no marked or appreciable difference either in grain size although that more slowly cooled showed a somewhat higher degree of pearlitic structure. Drop and tensile tests were also made; the former showing no impairment of toughness, and the latter only slight decreases in tensile properties for the slowly cooled rail specimens.

Work of this character was carried on to some extent at three other mills in the study of the effect of thermal changes on intermediate manganese rails on the hot beds, one mill reporting that martensite could be produced by rapid air cooling of the rail head, projecting a stream of air against it.

Canadian National:

Summary of mill tests on 1929 rollings of intermediate manganese steel rails:

Weight of Section and type of rail	85 lb. "Head Free"
No. of Heats Cast	40
No. of Ingots rolled	485
No. of Rails rolled	2814

CHEMICAL COMPOSITION

Specification requirements		*Analysis of 40 Heats*	
Carbon ....0.50 to 0.65%	Min. 0.52	Max. 0.65	Average 0.595
Manganese ......1.30 to 1.60%	Min. 1.30	Max. 1.60	Average 1.442
Phosphorus....Not over 0.04%	Min. 0.021	Max. 0.040	Average 0.028
Sulphur...... Not over 0.055%	Min. 0.031	Max. 0.051	Average 0.041
Silicon ....Min. 0.15%	Min. 0.150	Max. 0.210	Average 0.170

Drop Test:
- Height of Drop ....20 Feet
- Distance between centers of supports .... 3 Feet
- Number of drop test pieces 120
- Drop test pieces broke on first blow ....Nil
- Average deflection at drop test ....1.47 Inches

Nick & Break Test:
- Number of tests 518
- Percentage of segregated rails to total rolled....................Nil

Rails rejected on account of pipe............................	33
Rails rejected for other causes	5
Total rails rejected	38
Rails accepted as No. 1....................................	2703
Rails accepted as No. 2....................................	73
Total rails rolled	2814
Percentage of piped rails to total rails rolled	1.17%
Percentage of No. 2 rails to total rails rolled.................	2.59%

Weight and Section of Rail......100 lb. ARA-A "Head Free" Plan S10 C-9.5
No. of Heats cast 41
No. of Ingots rolled 520
No. of Rails rolled 2924

CHEMICAL COMPOSITION

Specification requirements		*Analysis of 41 Heats*	
Carbon ....0.50 to 0.65%	Min. 0.53	Max. 0.64	Average 0.586
Manganese ......1.30 to 1.60%	Min. 1.30	Max. 1.73	Average 1.497
Phosphorus....Not over 0.04%	Min. 0.018	Max. 0.030	Average 0.025
Sulphur......Not over 0.055%	Min. 0.020	Max. 0.038	Average 0.028
Silicon ....Min. 0.15%	Min. 0.154	Max. 0.260	Average 0.198

Drop Test:
- Height of Drop ....22 Feet
- Distance between centers of supports .... 3 Feet
- Number of drop test pieces 125
- Drop test pieces broke on first blow.......................2—1.6%
- Average deflection at drop test ....1.06 Inches

Nick & Break Test:
- Number of tests 749
- Percentage of segregated rails to total rolled.................2.46%

Rails rejected on account of pipe	157
Rails rejected for other causes	18
Total rails rejected	175

Total rails accepted as No. 1 2569
Total rails accepted as No. 2 180

Total rails rolled 2924

Percentage of piped rails to total rails rolled 5.36%
Percentage of No. 2 rails to total rails rolled 6.15%

Results of Izod tests made on specimens from 1930 rollings.

CHEMICAL ANALYSIS

Specimen	*Heat No.*	*C.*	*Mn.*	*P.*	*S.*	*Si.*	*Drop Test Values*	*Izod Values foot/lbs.*		
1	*5183	.69	.79	.026	.029	.140	1.70	1.95	2	2
2	5183	.69	.79	.026	.029	.140	1.70	2	2	2
3	5183	.69	.79	.026	.029	.140	1.70	2	2	2
4	‡4162	.59	1.45	.028	.028	.095	1.20	5	5.5	5
5	4162	.59	1.45	.028	.028	.095	1.20	4	4	4
6	4162	.59	1.45	.028	.028	.095	1.20	4	4	5.5
7	‡1216	.60	1.36	.027	.027	.146	1.20	2	3	3
8	1216	.60	1.36	.027	.027	.146	1.15	3.5	3.5	3.5
9	1216	.60	1.36	.027	.027	.146	1.20	3.5	3.5	3.5
10	‡1223	.59	1.45	.037	.028	.052	1.20	4	4.5	4
11	1223	.59	1.45	.037	.028	.052	1.20	3	3.5	4
12	1223	.59	1.45	.037	.028	.052	1.20	3.5	3.5	3.5

* Carbon steel.
‡ Intermediate Manganese steel.

4. **Present contours or tabulated results of investigations on wear of rail heads on curves and also tangent track, comparing intermediate manganese with standard open hearth rails in similar service.**

What conclusions have you arrived at, based on your general observations of the two classes of steel?

Boston & Maine: Submitted a large number of contours on various types of steel under test on several curves; a summary of which is shown below. No general conclusions are given in the report.

BOSTON & MAINE RAILROAD

TABULATION OF WEAR ON RAILS

Square inches abraded per million tons during first twenty million tons of traffic.

Buckland, Mass.

Kind of Rail	*Curvatures*	*Super-elevation*	*Sq. Inches Abraded High*	*Sq. Inches Abraded Low*
130 lb. Carbon	4°-46′	6″	.0078 s.i.	.0056 s.i.
130 lb. Carbon heat treated	4°-24′	6″	.0048 s.i.	.0020 s.i.
*130 lb. Med. Manganese	3°-11′	5″	.0092 s.i.	.0064 s.i.

* Believe that the greater speed over the manganese rails accounts for some of the excess wear.

Hoosick Falls, N.Y.

Kind of Rail	*Curvatures*	*Super-elevation*	*High*	*Low*
130 lb. Med. Mang.	8°-37′	2½″	.0116 s.i.	.0105 s.i.
130 lb. Carbon	8°-37′	2½″	.0120 s.i.	.0082 s.i.
130 lb. Carbon H.T.	8°-37′	2½″	.0080 s.i.	.0065 s.i.
130 lb. Zirconium	8°-37′	2½″	.0110 s.i.	.0095 s.i.

130 lb. Chromium	8°-37′	2½″	.0150 s.i.	.0115 s.i.
100 lb. Carbon	8°-37′	2½″	.0130 s.i.	.0114 s.i.
100 lb. Krupp-carbon	8°-37′	2½″	.0145 s.i.	.0115 s.i.
100 lb. Med. Mang.	8°-37′	2½″	.0090 s.i.	.0069 s.i.
		Mechanicville, N.Y.		
130 lb. Med. Mang.	6°-06′	3½″	.0088 s.i.	.0093 s.i.

The 8°-37′ curve is protected by a slow board restricting the speed to twenty miles an hour. However, it is the custom of enginemen to allow the curvature of the track, with the aid of the brakes, to bring the speed of their trains down to the required limit, consequently the 130 lb. Intermediate Manganese and 130 lb. Carbon rails resist a greater load to some extent than other rails on this curve.

In line with the above we feel that the greater speed around the 3°-11′ curve laid with medium manganese accounts for discrepancies in wear between this rail and the carbon and carbon heat treated on the 4°-46′ and 4°-24′ curves, respectively.

D. L. & W.
WEAR OF RAIL ON CURVES AND TANGENT TRACK

Location	*Alinement*	*Grade*	*Wear per Million Tons Traffic Sq. In.* *O H*	*M M*	*% Red. Wear per Mil. Tons using M M*	*Million Tons carried Av.* *O H*	*M M*
Water Gap Curve High Rail	6°13′ 7°00′	0	.0093	.0078	16.13	64.31	54.47
Water Gap Curve Low Rail	6°13′ 7°00′	0	.0071	.0057	19.72	64.3	54.47
Cresco Curve High Rail	5°13′ 6°09′	—1.48	.0113	.00875	22.57	29.0	24.83
Cresco Curve Low Rail	5°13′ 6°09′	—1.48	.0095	.0066	30.53	47.50	41.30
Average on Curves			.0093	.00721	22.47		
Mountain View	Tang.	0	.0083	.0062	25.30	16.58	16.58
Towaco	Tang.	+0.53	.0027	....	....	102.17	....
Port Morris	Tang.	0	.0030	....	....	155.00	....
Water Gap (one-half M. West)	Tang.	0	....	.0015	....	....	58.34
Cresco (1 M. East)	Tang.	—1.48	.0019	....	....	220.00	....
Cresco (.5 M. West)	Tang.	—1.51	....	.0024	....	....	44.86
Elmhurst	Tang.	—0.91	.0075	....	....	15.50	....
Average on Tangent			.0047	.0034	27.66		

KANSAS CITY SOUTHERN

TESTS ON COMPARATIVE WEAR OF INTERMEDIATE MANGANESE AND HIGH CARBON RAIL ON A 5 DEGREE CURVE

INTERMEDIATE MANGANESE RAILS

Inside or Outside Rail	Heat Number	Ingot No.	Rail Letter	Area of Head 5/4/29	Area of Head 10/8/30	Car.	Mang.	Phos.	Sul.	Sil.	Indent. Depth in Inches
Outside	1M38090	22	A	3.90	3.73	.61	1.38	.025	.039	.17	.109
Outside	1M53081	5	A	3.85	3.76	.62	1.42	.016	.026	.13	.107
Outside	1M53081	16	A	3.86	3.79	.62	1.42	.016	.026	.13	.107
Inside	1M53081	18	A	3.84	3.76	.62	1.42	.016	.026	.13	.107
Inside	1M49072	6	A	3.85	3.79	.58	1.37	.030	.029	.15	.102
Inside	1M49073	4	A	3.85	3.80	.61	1.58	.024	.026	.17	.105
	Average head area			3.86	3.76						
				High Carbon Rail							
Outside	54055	4	F	3.80	3.76	.77	.75	.025	.026	.14	.115
Outside	52049	21	B	3.85	3.78	.71	.65	.024	.032	.18	.109
Inside	55050	12	D	3.90	3.78	.72	.80	.029	.031	.21	.106
Inside	54055	1	C	3.83	3.72	.77	.75	.025	.026	.14	.115
	Average head area			3.85	3.76						

We do not consider the above test of sufficiently long duration to draw any conclusions. The rails were laid alternately contiguous on the same curve May 4, 1929, and at the time of the readings, made October 8, 1930, had carried 8,120,000 gross tons of freight traffic exclusive of locomotives, and a passenger traffic of four trains daily.

N. Y. C. Lines.—The New York Central—East of Buffalo submits comparisons under fairly similar traffic conditions on curves 4 degrees or less as shown by the table shown below. The service in general is too short to draw conclusions.

Contours from the Pittsburgh & Lake Erie continue to show about 25 per cent reduction of abrasion on the high rail for intermediate manganese compared to high carbon open hearth.

Data from the Indiana Harbor Belt showed an increased life of approximately 30 per cent on 4 to 5 degree curves.

Wear measurements were taken on several single mile stretches of track laid with 127 pound Dudley section rails of both intermediate manganese and open hearth steel. Several measurements were taken in each mile and averaged. The work was confined to rail rolled and laid in 1926 and 1927. The average wear for either type of steel was approximately 3/128 inch, though in general was slightly lower for intermediate manganese than for standard open hearth. The measurements referred to here were all on tangent high speed tracks.

C. B. & Q.—No contours or tables were submitted, but the following statement was incorporated in the report:

"Our Maintenance Engineers are of the opinion that we can expect from 10 per cent to 15 per cent more service out of intermediate manganese rails as compared with ordinary open-hearth rails."

Northern Pacific.—While we have no contours or tabulated results to offer, our general opinion is that intermediate manganese rail on curves, particularly on the low side, seems to wear somewhat slower than standard rail, and furthermore the low rails do not seem to be as scabby or corrugated as do the standard.

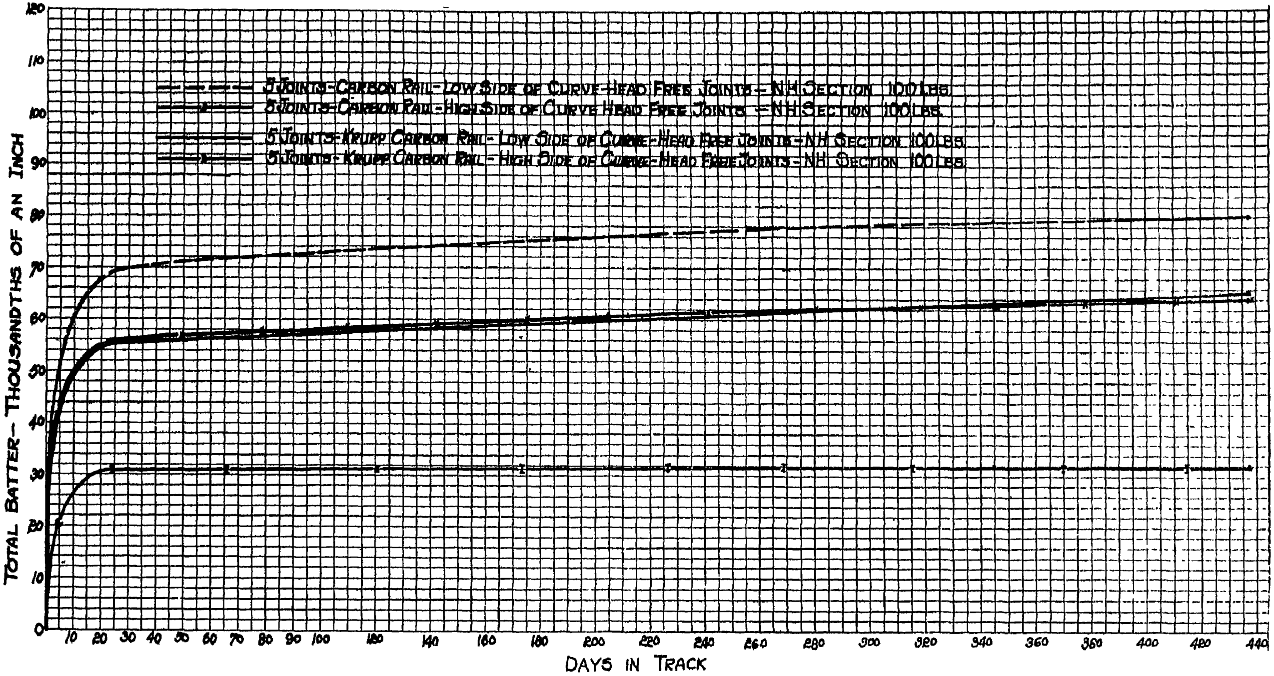
New York Central—East of Buffalo

Comparative Statement of Rail Wear of Ordinary Open Hearth Rail to Medium Manganese

Plan No of Section	Location of Section: Division	Location of Section: Track	Location of Section: Mile Post	Degree of Curve	Elevation of Curve	Gauge	Weight of Rail	Age in Track	High Rail: Kind	High Rail: Sq. In. Abraded	Low Rail: Kind	Low Rail: Sq. In. Abraded
A-1	Eastern	2	65 Pole 30-3/4	1° 25'	4"	4' 8-7/16"	127#	3 mo.	O.H.	0.06	O.H.	0.03
A-2	"	2	65 Pole 31-1/4	1° 25'	4"	4' 8-1/2"	127#	3 mo.	M.M.	0.08	M.M.	0.04
B-1	Eastern	2	67 Pole 54	1° 00'	2-1/2"	4' 8-1/2"	127#	5 mo.	O.H.	0.06	O.H.	0.04
B-2	"	2	67 Pole 53-3/4	1° 00'	2-1/2"	4' 8-3/8"	127#	5 mo.	M.M.	0.04	M.M.	0.02
C-1	Eastern	4	70 Pole 07-3/4	2° 00'	4-1/2"	4' 8-7/16"	127#	5 mo.	O.H.	0.03	O.H.	0.06
C-2	"	4	70 Pole 08	2° 00'	4-1/4"	4' 8-7/16"	127#	5 mo.	M.M.	0.02	M.M.	0.07
D-1	Mohawk	2	249.71	1° 00'	2"	4' 8-1/2"	127#	14 mo.	O.H.	0.03	O.H.	0.02
D-2	"	2	249.71	1° 00'	2"	4' 8-1/2"	127#	14 mo.	M.M.	0.03	M.M.	0.02
E-1	Buffalo	4	C-532-B-8	1° 00'	1-1/2"	4' 8-1/2"	105#	62 mo.	O.H.	0.13	O.H.	0.07
E-2	"	4	C-532-B-8	1° 00'	1-1/2"	4' 8-7/16"	105#	16 mo.	M.M.	0.10	M.M.	0.05
F-1	Penna.	S	Opp. Lock Haven Station	4° 00'	4-3/4"	4' 8-3/4"	105#	23 mo.	O.H.	0.03	O.H.	0.02
F-2	"	S	West of Youngdale near Br B3B	4° 00'	3-1/4"	4' 8-1/4"	105#	24 mo.	M.M.	0.04	M.M.	0.02
G-1	Penna.	S	So. of Slate Run	2° 45'	4"	4' 8-9/16"	105#	34 mo.	O.H.	0. 29	O.H.	0.11
G-2	"	S	So. of Slate Run	2° 45'	4"	4' 8-1/2"	105#	34 mo.	M.M.	0.10	M.M.	0.12
H	Penna.	S	So. of Slate Run	Tangent	0"	4' 8-5/16"	105#	34 mo.	O.H. East	0.23 Rail	M.M. West	0.19 Rail

HOOSICK FALLS, NEW YORK

TOTAL BATTER—EIGHT AND ONE HALF DEGREE CURVE



Chesapeake & Ohio.—No contours submitted, but report that the rail was laid on curves between 5 and 9 degrees, and that heavy coal freight operates over the districts where this rail was laid.

5. **Present general or specific data on the batter and chipping of rail ends, comparing intermediate manganese and standard open hearth rail.**

Boston & Maine.—Has made a careful study of batter for various types of steel and on several curves. Comparative batter measurements for rails on a 8 deg. 30 min. curve as indicative of the data submitted, are shown below:

N. Y. C. Lines.—Measurements were taken principally on tangent track on the 127 pound Dudley section rails which had been in from 3 to 4 years. The procedure was to take a continuous stretch of track and measure both rails for a distance of one half to one mile, recording the batter and chipping for each receiving rail end. Readings varied between zero and 5/128, with an average close to 3/128 inch for both classes of steel. Records on chipping showed some stretches of track with practically none, while the number or percentage on others was high. This feature seemed to be associated more with hardness of metal, differences in height of adjacent rails, and also to a lesser extent on actual joint gap at the time measurements were taken. On an average the medium manganese rails showed lower rate of chipping.

Northern Pacific.—Report they have not noticed any material difference.

6. **Present a Table of Intermediate Manganese Rail Failures, summarizing failures from date rail was laid to latest date records are available.**

Year Rolled	Mill	Tons Rolled	Trans. Fiss.	Comp. Fiss.	Horiz. Fiss. or Split	Split Head	Crush. Head	Web	Base	Misc. Bk.	Total	Section
				Boston & Maine—To August 31, 1930								
1929	Steelton	29139	—	—	—	50	—	—	—	—	50	130-RE
1929	Steelton	15803	—	—	—	24	4	1	18	4	51	100-NH
				Canadian National—To December 31, 1929								
1929	Dominion	1359	—	—	—	12	—	—	—	—	12	85-HF
1929	Algoma	1590	1	—	—	23	1	1	—	—	26	100-HF
				Louisville & Nashville—To January, 1930 (Rails removed)								
1929	Tennessee	1986	16	—	121	19	—	1	4	—	161	100-RE
				Northern Pacific—To August 1, 1930								
1926	Illinois	752	—	—	—	7	—	—	—	1	8	130-RE
1926	Illinois	953	—	1	8	13	—	—	1	—	23	100-RE
				Southern Railway—To August 1, 1930								
1929	Tennessee	1650	1	—	—	2	—	—	—	—	3	100-RE

Delaware, Lackawanna & Western—To September 1, 1930

Year Rolled	Mill	Tons Rolled	Trans. Fiss.	Comp. Fiss.	Horiz. Fiss. or Split	Split Head	Crush. Head	Web	Base	Misc. Bk.	Total	Section
1925	Steelton	2913	—	—	—	—	—	—	—	—	—	118-DLW
1925	Steelton	11673	4	1	11	37	—	7	—	—	60	130-RE
1926	Steelton	4332	—	—	—	—	—	4	—	—	4	105-DLW
1926	Steelton	11495	11	—	2	46	—	3	—	—	62	130-RE
1927	Steelton	4669	1	—	—	—	—	—	—	—	1	105-DLW
1927	Steelton	16080	1	—	2	43	—	2	1	—	49	130-RE
1928	Steelton	3677	2	—	1	13	—	—	—	—	16	105-DLW
1928	Steelton	16240	2	—	2	89	—	3	1	—	97	130-RE
1929	Lacka.	1896	—	—	—	—	—	1	—	—	1	105-DLW
1929	Steelton	544	—	—	—	—	—	—	—	—	—	105-DLW
1929	Lacka.	12747	—	—	6	124	—	2	—	—	132	130-RE
1929	Steelton	3491	—	—	2	57	—	—	—	—	59	130-RE
1930	Lacka.	2232	—	—	—	—	—	—	1	—	1	105-DLW
1930	Lacka.	7297	—	—	—	3	—	—	1	—	4	130-RE

Kansas City Southern—To August 1, 1930

Year Rolled	Mill	Tons Rolled	Trans. Fiss.	Comp. Fiss.	Horiz. Fiss. or Split	Split Head	Crush. Head	Web	Base	Misc. Bk.	Total	Section
1928	Carnegie	840	—	—	—	2	—	—	—	—	2	115-Dudley
1929	Bethlehem	761	—	—	—	1	—	—	—	—	1	100-RE
1929	Bethlehem	541	—	—	—	—	1	—	—	—	1	100-RE

Atchison, Topeka & Santa Fe

Year Rolled	Mill	Tons Rolled	Trans. Fiss.	Comp. Fiss.	Horiz. Fiss. or Split	Split Head	Crush. Head	Web	Base	Misc. Bk.	Total	Section
1927	Inland	3113	—	—	—	—	—	—	—	1	1	110-RE
1928	Colorado	966	—	—	—	—	—	—	—	—	—	90-SG
1928	Colorado	12285	—	—	—	3	—	—	—	—	3	110-RE

Note.—Santa Fe also reported 5 scrappy head rails.

New York Central Lines—To July 1, 1930

New York Central—East

Year Rolled	Mill	Tons Rolled	Trans. Fiss.	Comp. Fiss.	Horiz. Fiss. or Split	Split Head	Crush. Head	Web	Base	Misc. Bk.	Total	Section
1926	Lacka.	4590	3	5	—	32	54	3	2	4	103	127-Dudley
1927	Lacka.	2476	2	—	—	2	8	—	—	—	12	127-Dudley
1928	Lacka.	14503	—	—	—	5	7	—	—	1	13	127-Dudley
1929	Lacka.	34757	—	—	—	5	18	3	—	—	26	127-Dudley
1925	Lacka.	1367	16	5	—	—	22	—	—	1	44	105-Dudley
1926	Lacka.	3033	11	3	—	—	19	—	—	—	33	105-Dudley
1927	Lacka.	2281	1	—	—	—	7	—	—	2	10	105-Dudley
1928	Lacka.	12904	—	1	—	1	2	1	2	3	10	105-Dudley
1929	Lacka.	5081	—	—	—	—	—	3	—	—	3	105-Dudley

Boston & Albany

Year Rolled	Mill	Tons Rolled	Trans. Fiss.	Comp. Fiss.	Horiz. Fiss. or Split	Split Head	Crush. Head	Web	Base	Misc. Bk.	Total	Section
1926	Lacka.	975	5	—	—	6	5	—	1	1	18	105-Dudley
1927	Lacka.	1004	5	—	—	3	2	—	—	—	10	105-Dudley
1929	Lacka.	1627	—	—	—	2	—	—	—	—	2	105-Dudley

New York Central—West

Year Rolled	Mill	Tons Rolled	Trans. Fiss.	Comp. Fiss.	Horiz. Fiss. or Split	Split Head	Crush. Head	Web	Base	Misc. Bk.	Total	Section
1928	Lacka.	2591	—	—	—	—	—	—	—	—	—	127 Dudley
1929	Lacka.	5824	—	—	—	—	3	—	—	1	4	127 Dudley
1926	Illinois	3431	4	—	—	28	66	—	—	—	98	127 Dudley
1927	Illinois	7974	—	—	—	3	9	1	—	—	13	127 Dudley
1928	Illinois	19163	—	—	—	5	—	—	—	—	5	127 Dudley
1929	Illinois	20206	—	—	—	3	1	—	—	—	4	127 Dudley
1926	Illinois	1475	—	—	—	5	1	—	—	—	6	105 Dudley

Year Rolled	Mill	Tons Rolled	Trans. Fiss.	Comp. Fiss.	Horiz. Fiss. or Split	Split Head	Crush. Head	Web	Base	Misc. Rk.	Total	Section
					C. C. C. & St. L.							
1926	Illinois	2188	—	—	—	8	30	1	—	—	39	105 Dudley
1927	Illinois	166	—	—	—	—	—	—	—	—	—	105 Dudley
1929	Illinois	12506	—	—	—	—	—	—	—	—	—	127 Dudley
1929	Inland	6585	—	—	—	1	—	—	—	—	1	127 Dudley
					Ohio Central Lines							
1928	Illinois	5000	—	—	—	—	—	—	—	—	—	105 Dudley
1929	Illinois	4008	—	—	—	—	—	—	—	—	—	105 Dudley
					Pittsburgh & Lake Erie							
1926	Carnegie	1001	—	—	—	7	—	—	—	—	7	115 Dudley
1927	Carnegie	2667	—	—	—	1	—	—	—	—	1	115 Dudley
1928	Carnegie	2957	—	—	—	2	—	—	—	—	2	115 Dudley
1928	Carnegie	1873	—	—	—	—	—	—	—	—	—	115 Dudley

Note.—The New York Central Lines classify so-called horizontal fissures as either crushed or split heads, depending upon development of this defect.

7. How do intermediate manganese and standard open hearth rail failures compare, giving detailed statement, or general conclusions.

Boston & Maine.—The split head failures of the 130-lb. manganese have greatly exceeded the average of any other rail shipment in recent years.

Canadian National.—Intermediate manganese rails have not been long enough in use on these lines to form conclusions. They showed an abnormally high percentage of failures during the first year which was probably due to lack of experience of the mills in making this kind of steel.

C. B. & Q.—With the exception of a few heats which show numerous horizontal fissures our experience indicates that the failure rate of intermediate manganese rail is materially lower than standard open hearth rail.

D. L. & W.—Up to the present time the failures in intermediate manganese rails indicate a less number of transverse fissures, and a greater number of vertical and horizontal split heads than in plain open hearth.

N. Y. C. Lines.—Rails rolled from over 2,000 heats have been placed in service, yet rails from 24 heats account for 55 per cent of the total failures, indicating irregularities in composition, open hearth and rolling mill practice. The failures are almost entirely of the horizontal or vertical split type. While the rate of failure for this defect is much higher than for standard open hearth rails, failures of the interior transverse fissure type are decidedly less numerous.

Northern Pacific.—Only small tonnages have been installed, which indicate a rate of failure about twice that of the standard open hearth rails. This applies to comparisons of less than 1,000 ton lots, and of the 130-lb. section.

Southern Ry.—The intermediate manganese rail purchased has been in about one year, and while few failures have developed to date, there have been more failures, on a per hundred mile basis, in the intermediate manganese than in open hearth rail.

8. Report special tests or investigations on failed or defective intermediate manganese rails, and conclusions derived therefrom.

Canadian National.—Chemical analysis of failed rails checked and found within the limits of the specification.

Etchings and sulphur prints made of sections from failed (split head) rails and examined under microscope at magnifications of 100 to 1000 diameters. From these examinations it appeared that the cracks were the results of the strain lines in the metal which followed through segregated areas. Further examinations and tests are being carried out but not reported on as yet.

C. B. & Q.—Co-operative investigations were conducted with the Illinois Steel Company, Inland Steel Company and R. W. Hunt & Company, embodied in three reports. The work was mostly on failed 110 pound rails, which had developed horizontal and vertical split heads. Failures reported were mostly from the lower parts of the ingot. Figures shown below are minimum and maximum obtained.

Report No. 1.

Chemistry—Failed Rails—Carbon 0.61 to 0.66 Mang. 1.41 to 1.73
New Rails —Carbon 0.58 to 0.61 Mang. 1.31 to 1.38

Tensile Properties:

	Failed Rails Longitudinal	*Failed Rails* Transverse
Ultimate Strength	143000 to 145000	54,000 to 128000
Elongation	8.5 to 9.5	0.0 to 11.5
Red. of Area	10 to 11	0.0 to 21.0
	New Rails	
Ultimate Strength	128000 to 135000	125000 to 133000
Elongation	10.5 to 15.0	7 to 8
Red. of Area	15 to 22.5	9 to 17

All fractures were crystalline.

	Failed Rails	*New Rails*
Brinell	232 to 239	200 to 217
Charpy Impact	136 to 142	172 to 184
Torsion Test	51000 to 54000	73000 to 82000

Macro etching on failed rails—Spongy or porous centers with fairly numerous diagonal and vertical cracks or checks on the cross-sections. Splits follow to considerable extent the outline of the spongy center.

Micro etching on failed rails—Well defined martensite of needle-like structure. Cracks plainly shown in these areas. The surrounding structure was pearlitic.

Macro etching on new rails—Solid structure. No segregation and no cracks.

Micro etching on new rails—Fine pearlitic structure. No martensite.

Report No. 2—One failed rail of the vertical split type.
Carbon 0.73 Manganese 1.61
Sulphur print shows no segregation.
Marco-etching—shows fairly spongy center in head, extending into the web. Numerous diagonal and vertical checks or cracks are shown on the cross-section. Martensite partially indicated. Micro-etching—Patches of martensite are clearly defined with cracks running across these areas.

Report No. 3—16 failed rails investigated out of the 52 returned. They were mostly D and E rails, and included vertical and horizontal splits as well as several horizontal splits at the rail ends.
Chemistry—Carbon 0.62 to 0.68 Manganese 1.44 to 1.64
Brinell—255 to 293 on head sections.
Sulphur prints—Fairly uniform. No segregation.
Macro-etching—Spongy or porous center with small cracks.

The splits follow through the outline of the spongy center, which is clearly shown on several etched cross sections. Micro-etching—12 to 16 of the rails showed thermally altered top surface from wheel burning or slipping. In the cross section below were martensite areas with cracks running through these zones. The surrounding structure was troostite and sorbite.

A special experiment is reported where one section of a failed rail was heated to 1800°F., then cooled by a fan and martensite was reproduced in this manner.

D. L. & W.—Has made a study by means of a series of graphs or charts showing carbon and mangenese contents of all heats rolled, and also similar charts for failed rails. These show quite plainly that failures are largely in the upper or top portions of the carbon and manganese ranges.

A large number of O and M analyses showed absence of any important or prominent segregation.

N. Y. C. Lines.—Carbon and manganese of heats and failed rails studied and plotted up. Failures mostly near the top of the specified limits.

Tests made on a number of representative failed rails. Carbon segregation small and unimportant. Tensile properties high, except for occasional low elongation and reduction of area. Sulphur prints show sound metal with but few streaks, spots or inclusions. Brinell hardness numbers generally high, running from 250 to 300 or higher. Structure under the microscope mostly fine grained pearlite bordering into sorbite. A number of tests carried on by etching to bring out martensite, but none found either at the mill or railroad laboratory. Deep etchings generally showed shattered condition in interior of head as indicated on longitudinal slabs. This was the most prominent feature, and seemed to be associated more with the failure or defect than any other property or condition found.

A. T. & S. F.—Makes a report on one rail investigated, after having furnished considerable information on their report submitted the year previous. The rail in question was a degraded X rail that failed through a bolt hole. The manganese content was 1.85 per cent, which was outside the limits of the present specification.

9. What conclusions, briefly stated, have you arrived at as to the relative merits of intermediate manganese compared to standard open hearth rails?

Boston & Maine.—No definite conclusions can be stated due to the short time rail has been in track.

Canadian National.—No conclusions arrived at.

C. B. & Q.—We have been more or less disturbed by the numerous horizontal fissures occurring in certain heats of a few rollings of intermediate manganese rail, and are awaiting developments with considerable interest. The mill people and mill inspectors are of the opinion that the situation is not serious and that ways and means can probably be found to remedy this trouble. Outside of these horizontal fissures we are convinced that the intermediate manganese rail is definitely superior to ordinary standard open hearth rail as to strength, toughness, durability and freedom from failures.

D. L. & W.—Judging from the chemical analysis of the rails that have failed due to split heads, the indications are that both the carbon and manganese content have been too high. The majority of the failures due to split heads have been in heats toward the higher limits in both carbon and manganese.

In the past the specifications allowed carbon as high as 0.67 and manganese to 1.60. In the future limits to be used will be carbon 0.52 to 0.65 and manganese 1.20 to 1.50.

The results secured from the use of intermediate manganese rail to date indicate that we are securing enough better service from this rail as compared with standard open hearth to warrant the continuance of its use. As previously stated, it is possible that the ranges of carbon and manganese have been too high and it is now the intention to reduce both slightly to see if the number of failures due to split heads cannot be reduced, and at the same time hold the transverse fissures to a minimum.

N. Y. C. Lines.—From the results of a further study of mill inspection and tests of rails, studies in the laboratories on both new and defective material, intermediate manganese rails continue to show superior physical properties, finer grain structure, more toughness, greater freedom from segregation, and smaller percentages of mill defects than standard open hearth rails. Wear on curves is in general considerably less. Batter, chipping and head wear measurements on tangent track do not show a material difference for the two classes of rails after 4 to 5 years service. Head failures of the vertical or horizontal split type have been higher with fissures much lower than for standard open hearth rails.

Study of failures indicates the desirability of lowering the carbon limits two or three points and the manganese 5 to 10 points. Steel rails with carbon in the vicinity of 0.70 and manganese around 1.70, either together or singly seems to be susceptible to failure, showing the desirability of using steel considerably lower in these elements.

Northern Pacific.—While the tonnage of intermediate manganese rail is perhaps too limited to draw any definite conclusions, there seem to be indications that these rails are peculiarly susceptible to the development of so-called horizontal fissures. If it is true that the addition of considerable percentages of manganese tends to predispose rails to the development of this type of failure without at least a corresponding decrease in other types of failure, it is not believed that the savings in the way of reduced rail wear justify the more extensive use of this type of rail.

Southern Ry.—Intermediate manganese rails have not been in service long enough to come to any conclusion as to relative merits compared with open hearth rail.

A. T. & S. F.—The results up to the present time are very favorable to intermediate manganese rail.

Chesapeake & Ohio.—In 1926 they bought 250 tons of the 100 lb. A.R.A.B. section from the Maryland plant, Bethlehem Steel Company, and laid on the James River Sub-division. All of this rail has given good service for wear equal to about three times as much wearing resistance as the standard open hearth rail over the same section, and has only developed five failures.

Two hundred and fifty tons were also bought from the Illinois Steel Company, Gary Works, of the same weight and section and laid at the same time, but on the Barboursville District. This rail started to break about one month after installation, and breaks continued throughout 1927 in increasing numbers until it became necessary to take out the entire tonnage in March, 1928. At that time there had been 106 failures.

Another test from the two mills might reverse this performance. As the rails we used were rolled to the same analysis, there seems no reason for the failure of rails from one mill and good performance of the rail from the other mill.

We have practically eliminated excessive wear on the outside rails of curves by the use of rail greasing machines and are not considering the further use of manganese rail.

OTHER ALLOY STEEL RAILS

Boston & Maine.—

1. Tonnage Purchased:

Kind	*Company*	*Plant*	*Weight*	*Section*	*Tons*
Chromium	Bethlehem	Steelton	130 lb.	R.E.	10.6
Zirconium Treated Med. Mang.	Bethlehem	Steelton	130 lb.	R.E.	69

2. The composition of standard open hearth rails was changed so that 0.50 per cent carbon was replaced by 1.39 per cent chromium; other specifications remaining the same. While steel conforming to specifications of intermediate manganese was in the ladle, 0.035 per cent zirconium was added to give this alloy rail.
3. The zirconium treated medium manganese was tested by the U.S. Bureau of Standards for Endurance Properties. Results published in A.R.E.A. Bulletin, Vol. 31, No. 326, June, 1930.
5. Batter curves are attached.

   Chipping

   4 chipped ends on 15 Chromium Rails
   10 chipped ends on 60 Carbon Rails
   6 chipped ends on 60 Zirconium Rails
6. No rail failures to August 31, 1930, after 14 months service.
9. The chromium rails were too soft, consequently the service life will be shorter than standard carbon rails. The zirconium rails wear at approximately the same rate as medium manganese rails.

Exhibit B

Heat Treated Steel Rails

QUESTIONNAIRE ON HEAT TREATED RAILS

1. Rails purchased, not previously reported, giving following details:

   COMPANY PLANT NO. RAILS LENGTH ROLLED WEIGHT SECTION
2. Report results of special tests on new rails, comparing treated versus untreated.
3. Present contours or tabulated results of investigations on wear of rail heads, comparing treated and untreated rails, giving details of curvature, tonnage, age of rail, etc.
4. Present general or specific data on batter and chipping of rail ends, comparing treated and untreated rails.
5. Itemized list of any rail failures.
6. Report results of investigations on any failed heat treated rails.
7. What conclusions, briefly stated, have you arrived at of the relative merits of treated compared to untreated rails?

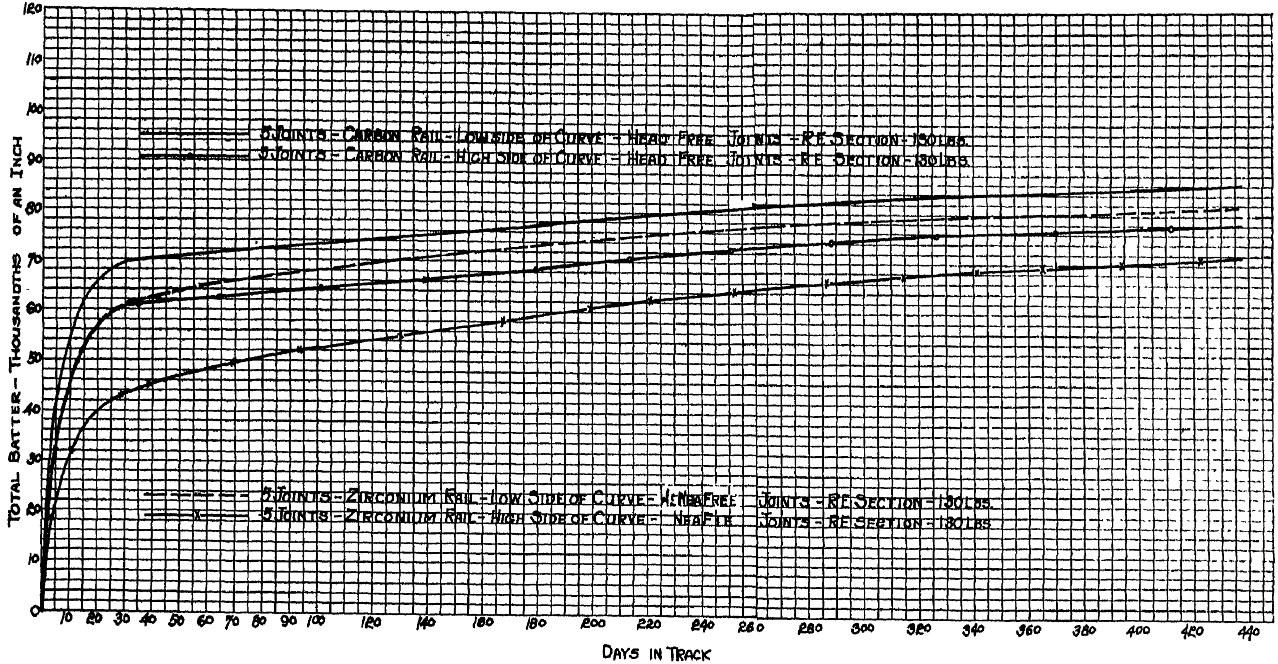
Replies to the questionnaire indicate that the railroads have been marking time during the past year so far as heat treated rails are concerned. The only new tonnages reported are 500 tons for the Delaware and Hudson, and 150 tons for the Interborough Rapid Transit Company, which were purchased from the Steelton plant, Bethlehem Steel Company.

The reports show that no failures of any type have developed which is even all the more remarkable when consideration is given to the fact that these heat treated rails are in about the most severe service on the various railroads.

Batter and chipping, as well as crosswise flow, particularly on the low side of curves is much less for treated compared to untreated rails.

Hoosick Falls, New York

Total Batter—Eight and One Half Degree Curve



Data as to wear is indicated in the comparisons shown below.

Several steel mills have been experimenting with heat treatment of rails, but the only one producing on a commercial basis is the Steelton plant of the Bethlehem Steel Company. Under the direction of E. F. Kenney, Metallurgical Engineer, the process has been further perfected, and we are indebted to Mr. Kenney for the following description of the present method of operation:

HEAT TREATMENT OF RAILS

Rails to be treated are manufactured in the same manner as ordinary rails up to the point where the latter are pushed from the runway on to the cooling beds. The rails for treatment proceed on the runway to the Treating Plant. From the runway they are pushed into an elevating device which rotates them in a position where two of them are seized by a crane which holds them suspended horizontally with the head down. They are immersed in water in this position when the temperature is just above the critical range, and held immersed for about one-half minute (the exact interval depending on the section). Immediately after removal from the quench, equalization of the temperature of the various parts of the quenched rail is accomplished in a bath of 170 tons of molten lead. This rapidly reheats the parts which have been most rapidly cooled, and in less than three minutes every part of the rail is brought to a uniform temperature. The stresses incidental to quenching are at the same time relieved, so that the rail enters the annealing furnace free from temperature differentials and from internal stresses. This rapid equalization permits of thorough quenching without risk of the rail cooling to temperatures where rail steel becomes brittle. This lead equalization has simplified the annealing, and results in a much straighter rail than was obtained before its use. Means have been provided for hot straightening rails after they have been annealed, so that final straightening involves only very light work.

The improvements noted have so far perfected the control in treatment that we have been warranted in reducing the annealing temperature, producing rails higher in elastic limit and Brinell hardness than the rails treated earlier.

Aside from the first lot of highly experimental rails, none of the rails treated from the mill heat (approximately 800 tons), which have been in track for nearly two years, have failed, although rails from some of the same heats which were untreated have failed by development of transverse fissures.

Baltimore & Ohio.—Wear on tangent rails, and upon those located on the four degree and eight degree thirty minute curves has been so slight as to not justify recording.

The average abrasion of untreated high and low rails compared to heat treated on a ten degree curve are given below:

	Treated Rail	*Untreated Rail*
Number of rails in test	15 high—15 low	7 high—7 low
Elevation of curve	3 in.	3 in.
Speed limit	20 m.p.h.	20 m.p.h.
Tonnage for 18 months	25,700,000	25,700,000
Av. Area Abraded-High rails	0.231 sq. in.	0.329 sq. in.
Av. Area Abraded-Low rails	0.175 sq. in.	0.201 sq. in.
Carbon content	0.72—0.89	0.77—0.84
Manganese content	0.50—0.90	0.55—0.75

From the abrasion sections, the relative rate of wear to date is, assuming heat treated rail as 100 per cent:

Heat treated	100 %
Untreated	130.5%

The average batter at ½ inch from rail ends is from two to three thousandths of an inch less on the heat treated than on untreated rail.

Boston & Maine.—Submitted a number of contours with tonnage data indicated, which shows a much lower rate of wear than any other steel under investigation. Relative wear is shown in the charts included in their report on intermediate manganese rails.

Batter measurements show much lower values than for any other type of steel. As to chipped ends, there are 17 on sixty heat treated rails, against 10 on sixty standard untreated carbon rails.

Their report concludes that the wearing qualities, both flange and rail end, exceed any other rail they have under test.

N. Y. C. Lines.—Sperry car run over the heat treated rails on one curve. The rails, particularly on low side, are badly burned and showed up with many three pen indications on the tape. In addition the rails had a number of surface bends due to gagging during straightening, and these also showed up on the tape. Hand checks made at several locations where three pen indications were obtained, but the results were negative.

Batter at the ends shows practically no difference on the high side between treated and untreated rails. On the low side of the curves the treated rail is battering, chipping and flowing considerably less than untreated rail.

Wear measurements show as follows:

	High Rails Area Abraded	*Low Rails Area Abraded*	*Average Area Abraded*
Treated Rails	.292 sq. in.	.102 sq. in.	.197 sq. in.
Untreated Rails	.236 sq. in.	.225 sq. in.	.231 sq. in.

Taking the untreated rails as 100%, the wear for the treated rails is 85.3%.

Norfolk & Western.—
Their installation is on a six degree curve; the rails having been in for approximately three years. Contours recently taken show that taking the untreated rails as 100%, the wear for the treated rails is 53.2%.

Southern Pacific.—
The rails are of the 130 lb. P.S. section and were installed in August, 1928, distributed as follows:

0.088 miles on 10° 15′ curve (No. 56)
0.053 miles on 9° 52′ curve (No. 71)
0.086 miles on 10° 25′ curve (No. 72)
Grade of track—2.02 per cent on all curves.

Tonnage over track from August 20, 1928, to June 30, 1930, has been 36,078,209 G.T.

Following tabulation shows comparison of wear, in sq. in., during this period:

Curve No.	*Degree*	*Heat Treated Rail High*	*Heat Treated Rail Low*	*Untreated Rail High*	*Untreated Rail Low*
56	10° 15′	0.47	0.22	0.50	0.42
71	9° 52′	0.21	0.15	0.30	0.26
72	10° 25′	0.16	0.12	0.26	0.25
Average		0.280	0.163	0.353	0.310

There is a slight amount of chipping on the high side rails, and considerable chipping on low side rails, indicating no particular advantage in this respect.

REPORT OF COMMITTEE XIII—WATER SERVICE AND SANITATION

R. C. BARDWELL, *Chairman;*
W. M. BARR,
ARMSTRONG CHINN,
R. W. CHORLEY,
R. E. COUGHLAN,
W. L. CURTISS,
J. H. DAVIDSON,
B. W. DEGEER,
L. E. ELLIOTT,
R. N. FOSTER,
C. H. FOX,
J. H. GIBBONEY,
W. P. HALE,
J. P. HANLEY,
L. A. HENRY,
E. G. HEWSON,
J. R. HICKOX,
R. L. HOLMES,
H. F. KING,
C. R. KNOWLES,
C. H. KOYL,
P. M. LABACH,
E. G. LANE,
E. M. GRIME, *Vice-Chairman;*
J. J. LAUDIG,
W. B. MCCALEB,
W. A. MCGEE,
H. L. MCMULLIN,
E. M. MILLER,
S. B. MITCHELL,
W. B. NISSLY,
A. B. PIERCE,
O. T. REES,
J. A. RUSSELL,
H. E. SILCOX,
D. A. STEEL,
R. M. STIMMEL,
R. A. TANNER,
W. O. TOWSON,
F. P. TURNER,
H. W. VANHOVENBERG,
J. C. WALLACE,
J. B. WESLEY,
A. E. WILLAHAN,
DENNISTOUN WOOD,
F. D. YEATON,

Committee.

To the American Railway Engineering Association:

Your Committee on Water Service and Sanitation presents below its report to the Thirty-Second Annual Convention on the following subjects as assigned by the Board of Direction:

(1) Revision of the Manual: Committee reports progress.

(2) Cause and Extent of Pitting and Corrosion of Locomotive Boiler Tubes and Sheets: Progress report appears as Appendix A.

(3) Relative Cost of Eliminating Impurities in Locomotive Boiler Water Supply and Value of Treatment: Progress report appears as Appendix B.

(4) Standardization of Equipment and Materials Used in Railway Water Service: Final report is submitted in Appendix C.

(5) Automatic and Remote Control of Pumping Equipment: Final report is submitted in Appendix D.

(6) Development of Deep Well Pumping Equipment: Committee reports progress.

(7) Design and Maintenance of Track Pans for Locomotive Supply: Committee reports progress.

(8) Protection of Water Pipe Line System from Electrolysis: Final report is submitted as Appendix E.

(9) Application and Comparative Economy and Effectiveness of Various Coagulants Used in Softening and Clarifying Water for Locomotive Boilers: Committee reports progress.

(10) Chemical Control and General Supervision of Water Softening Plants: Final report is submitted as Appendix F.

(11) Protection of Boilers and Boiler Materials from Corrosion and Deterioration While in Storage: Final report is submitted as Appendix G.

Bulletin 333, January, 1931.

(12) Progress Being Made by Federal and State Authorities on Regulations Pertaining to Drinking Water Supply: Progress report appears as Appendix H.

(13) Sewage Disposal Facilities Where Sanitary Facilities are not Available: Committee reports progress.

(14) Methods of Laying Cast Iron Pipe, and Prepare Complete Specifications: Final report is submitted as Appendix I.

Action Recommended

Your Committee recommends the following action on its report:

(1) That the subject matter in the Manual be again referred to the Committee for further study and report.

(2) That the progress report on pitting, and corrosion of boiler tubes and sheets, be received as information and the subject reassigned to the Committee for further study and report.

(3) That the progress report on cost of eliminating impurities in locomotive boiler water be received as information and the subject continued.

(4) That the final report on standardization of railway water service equipment be received as information.

(5) That the final report on automatic and remote control of pumping equipment be received as information.

(6) That the subject of development of deep well pumping equipment be reassigned for further study and report.

(7) That the subject of design and maintenance of track pans for locomotive supply be reassigned for further study and report.

(8) That the final report on protection of pipe lines from electrolysis be received as information.

(9) That the subject of application and comparative economy and effectiveness of various coagulants be reassigned for further study and report.

(10) That the final report on control and supervision of water softening plants be received as information.

(11) That the final report on protection of boilers and boiler materials from corrosion and deterioration while in storage be received as information.

(12) That the progress report on drinking water regulations be received as information and the subject be reassigned for further study and report.

(13) That the subject of sewage disposal facilities where sanitary facilities are not available be reassigned for further study and report.

(14) That the final report on methods of laying cast iron pipe be accepted as information and that portion of the report giving specifications for laying cast iron pipe be accepted for inclusion in the Manual.

Respectfully submitted,

COMMITTEE ON WATER SERVICE AND SANITATION,

R. C. BARDWELL, *Chairman.*

Appendix A

(2) PROGRESS REPORT UPON THE CAUSE AND EXTENT OF PITTING AND CORROSION OF LOCOMOTIVE BOILER TUBES AND SHEETS, GIVING CONSIDERATION TO THE QUALITY OF WATER, CHARACTER OF METALS, METHODS OF MANUFACTURE AND TYPES OF BOILER CONSTRUCTION

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Previous reports of this Committee on this subject have discussed fully, the theories concerning the causes of pitting and corrosion in locomotive boilers. (See pages 493-495 of Volume 23 of Proceedings). These reports have also outlined several methods that have been recommended for inhibiting pitting and corrosion. (See pages 411-413 of Volume 31 of Proceedings). Some of these methods have been used with very gratifying results on several railroads. During the past year no new methods of merit for preventing pitting and corrosion have come to the attention of the Committee.

The treatment of the boiler feed-water so as to maintain the proper caustic alkalinity in the water in the boiler, has thus far had a much wider application than any other method suggested for inhibiting pitting and corrosion, and this method has generally been successful.

The use of the counter-electric potential method, with the use of added chemicals, to the feed-water, has expanded considerably during the past year and some very satisfactory results have been reported.

Very carefully conducted tests with open feed water heaters, which remove over 80 per cent of the dissolved oxygen from the feed-water before it enters the boiler, have been conducted and results obtained demonstrate the efficacy of this method of preventing pitting and corrosion, when properly supervised.

A great many service tests are now being carried out on various railroads, using the methods outlined above, as well as some others. Also there are many service tests being conducted with fire-boxes and tubes, manufactured of different metals and alloys, recommended as resisting corrosion. These tests are, for the most part, incomplete, but by this time next year, we should be able to present an interesting summary of the results of these tests.

Appendix B

(3) RELATIVE COST OF ELIMINATING IMPURITIES IN LOCOMOTIVE BOILER WATER AND THE VALUE OF TREATMENT—WITH RESPECT TO CHEMICALS AND COMPOUNDS APPLIED DIRECT TO LOCOMOTIVE BOILERS AND ROADSIDE TANKS, AND CONDITIONS UNDER WHICH THEY MAY BE DESIRABLE

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In our report of 1927 (Proceedings, page 227) we stated our belief that for boiler purposes "few natural waters are so good that some form of treatment does not improve them."

In our report of 1928 (Proceedings, page 134), we stated our belief that for very hard natural waters there is no question that they should be both softened and cleaned of precipitate before they reach the boiler, and that the advantage of clean soft water to a boiler is so great that the expression "complete treating plants are not justified" should be used with caution.

Yet there is some point, dependent on the character of the water and the amount used, below which "interior treatment" will serve the purpose, where definitely recognized chemicals are used under proper supervision.

Even the most experienced are not yet of one mind as to the location of this point either in the scale of hardness or in the amount of water used at any one station, and the reasons for the lack of agreement are principally two. First, some are trying to determine the point below which interior treatment is desirable from the standpoint of economy while yet maintaining good operating conditions for the average engine crew, but others are trying to determine a higher point below which interior treatment is possible by the aid of various expedients which will bet the engine over the road. Second, the location of the point is changing every year because of improvements in methods and applicances.

A few years ago the addition of chemicals for interior treatment was a rather haphazard matter except with a few careful students, and no regular examinations of the water in the boiler were made except by the same careful few, while now it is recognized by everyone that the addition of chemicals must be exact and that regular examination of the water in the boiler is the best test thereof.

Continuous deposition of sludge within the boiler requires regular and frequent blowing out, and very considerable improvement in boiler blowdown equipment and operation is also found in recent years.

Attention was drawn by this Committee in 1928 Proceedings, page 137, to the fact that the mechanical condition of the sludge, that is, the size of its particles, has much to do with its tendency to cause foaming, and every effort is now being made so to precipitate the sludge as to get a large preponderance of heavy particles.

These efforts, and some others, all tend to increase the field for successful interior treatment; and, at the same time, there has been continuous reduc-

tion of expense of operation of complete treating plants by substitution of automatic appliances for hand labor; so that, coming down from very hard waters and large plants, we reach something like 7 or 8 grains-per-gallon hardness and something like 5,000 gallons per day used before we find that the savings in boiler maintenance and operation are less than the expense of operation of a complete treating plant plus a 10 per cent allowance for interest and depreciation. And, on the other hand, we find that many waters much harder than 8 grains-per-gallon can be handled by modern methods of interior treatment.

In this overlapping space, within which both processes are economical, we can perhaps find a means of deciding between them if we rearrange this year's title to read:

(a) Under what conditions is it desirable to soften water within the boiler by the aid of chemicals applied either to the boiler or to the roadside tank?

(b) What are the relative costs and values of various chemicals so applied?

On the first question some light can be thrown by a discussion of boiler foaming.

Boiler foam when particles of sludge or mud, especially very small and light particles, get to the surface of the water in the boiler and so cover and strengthen the watery films of the stream bubbles that the films break with difficulty, and the bubbles accumulate on the surface of the water until when they do break, the steam is wet.

The less the sludge and the heavier the particles, the fewer the particles that will float. The purer and lighter the water, the more difficult it is for these particles to rise; the more sodium sulphate and chloride in solution in the water, and therefore the heavier the water, the easier for the particles to float.

The principal difference between water softened in a plant set apart for the purpose and water softened in a boiler by chemical added either to the boiler or to the roadside tank, is that the first contains only 2 or 3 grains-per-gallon of matter which can be precipitated in the boiler while the second deposits in the boiler all of the original matter which made it hard.

Water softened to 2 grains-per-gallon before it reaches the boiler deposits little sludge, but its particles are of necessity very small and light and the tendency of such water to foam is greater than that of most hard waters. Water softened within the boiler deposits all the heavy sludge and as much fine sludge as the other water, so that on the whole, the tendency to foam of water softened within the boiler is greater than that of water softened outside.

Under these conditions it is apparent that the other factor affecting the tendency to foam—the heaviness of the water, which depends on the amount of dissolved salts, must be the deciding factor in ordinary cases.

Bearing in mind that we are trying to determine when it is desirable to use interior treatment, and not merely when it is possible; that we are thinking of the ordinary engine crew and not of the expert western crews who have handled foaming boiler water all their lives; that we are speaking of tonnage trains in fast main-line service; and remembering that these conditions call for water that can be used without foaming, up-hill or down, with-

out the use of anti-foam compound and without excessive blowing-down, we find ourselves limited to fairly good grades of water and fairly clean boilers. It is true that locomotives differ in their water-carrying power and that enginemen differ in their skill but, in general and for above conditions, the concentrated water in a locomotive boiler should not exceed 100 grains-per-gallon of total dissolved solids, and in ordinary cases that will limit the water to 15 grains-per-gallon as it goes to the boiler.

For traffic conditions as above, and for a few stations along the road, perhaps sandwiched in between lime-soda plants, it may be that an upper limit of 15 grains-per-gallon of alkali salts can be set, but we cannot set an upper limit to the hardness or the dissolved salts of waters which it is possible to use by means of interior treatment aided by anti-foam compound and unlimited blow-down.

Many railroads use interior treatment on waters whose use is small and whose hardness and sodium salts are low; and the statement that the operating expense of softening within the boiler is less than that of softening outside is true only of these waters of small use, low hardness and low alkali salts. On the Chicago, Milwaukee, St. Paul & Pacific, where there are several hundred miles of very hard waters formerly handled by the methods of interior treatment then current, there are now about 70 lime-soda softening plants and 20 soda-ash plants, and the annual cost of all the chemicals used, including some anti-foam compound, is less than the annual cost ten years ago of anti-scale and anti-foam compounds, and at that time the mileage between boiler failures on the road was 35,000 while now it is 5,000,000. Such examples of record, and there are many of them, supply the best data for comparing the relative costs and benefits of the various methods of handling such waters.

RELATIVE COSTS AND VALUES OF CHEMICALS USED IN BOILERS OR TANKS

Returning to a discussion of the chemicals used in softening in the boiler such waters as should be so treated:

Of the chemicals used in interior boiler treatment, soda-ash, first used by Porter in England in 1845, is so much cheaper than the various anti-scale compounds of which it frequently forms the principal part that many railroads have endeavored to train their engine crews in its use.

When the water in such a boiler is examined at regular intervals it is found to be soft and to have a sodium-carbonate-or-caustic alkalinity of 15 per cent of the total dissolved solids. When soda-ash is used in road locomotives the custom is to add to the water in the roadside tank enough dissolved soda-ash to neutralize the sulphate hardness, and enough more to equal 15 per cent of the total sodium sulphate and chloride in the water. Thus, when the treatment is exact, the gradual concentration in the boiler frequently makes the total alkalinity as high as 20 grains-per-gallon; and another circumstance sometimes makes it higher still, even up to 40 or 50 grains-per-gallon. This is from the fact that some waters react slowly with soda-ash, even at boiler temperature, and the precipitate is so fine that it does not settle well and the boiler starts to foam. The remedy for this is to

increase the charge of soda-ash, which in turn increases the size of the particles of precipitate so that they have less tendency to float, and the foaming ceases but the alkalinity of the boiler water rises.

Throughout the country, and particularly in the Northwest, are many natural waters with carbonate hardness and frequently 15 to 25 grains-per-gallon of sodium bi-carbonate (the equivalent of soda-ash) and it was observed years ago that when these waters are used in stationary boilers there is no scale, and no foaming if the boilers are kept well blown down. This knowledge appears to have been utilized first on the Chicago, Burlington & Quincy Railroad, in 1906, in the general use of soda-ash, added in solution to the roadside tanks in carefully calculated amounts according to the character of the water, and is still used to some extent on that road, but has been used to the exclusion of other methods of water softening on the Wabash, the Chicago & Alton, and the St. Louis-San Francisco.

For interior boiler treatment there are also a few reliable anti-scale compounds which are generally composed of soda-ash, tri-sodium phosphate, tannin compounds, and sometimes small proportions of other chemicals. The cost varies with the kind of water and runs between 3 cents and 15 cents per thousand gallons of water.

When the water in a boiler is properly treated with any of these compounds and the boiler is kept blown down below the foaming point, the regular examination of the water in the boiler on the arrival of the locomotive at a roundhouse will show a sodium-carbonate-or-caustic alkalinity of at least 3 grains-per-gallons.

The Canadian National Railways operates its line between Sarnia and Montreal, a distance of 511 miles, by this method, and those in charge ascribe the good condition of the boilers and the general freedom from foaming to a careful compliance with the rules that the boilers must be systematically blown down on the road and that at the daily roundhouse examinations of water from the boilers the sodium alkalinity shall not fall below 3 grains-per-gallon.

During the last few years there has been on the market a new chemical for this purpose, sodium aluminate, in either liquid or dry form. This chemical has one valuable property in water softening, in that it combines with magnesia to form a heavy precipitate which settles readily. Probably the chemical is never used in its pure form, but for interior treatment is combined with soda-ash, caustic soda and some substance to prevent too early precipitation in the pipes and in the boiler injector.

As said above, the field for interior treatment is broadening with the rapid movements in methods and appliances. Quite extensive tests are new under way to determine the kinds of waters to which each of the above chemicals is most suitable, and the relative costs with each. If the subject is continued until next year we hope to be able to present more definite figures than our present knowledge would justify.

Appendix C

(4) SIMPLIFICATION AND STANDARDIZATION OF EQUIPMENT AND MATERIALS USED IN RAILWAY WATER SERVICE

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Industrial standardization has advanced rapidly in this country since the Bureau of Simplified Practice was established by the Department of Commerce. Since that time the American Standards Association has been created and is now functioning to co-ordinate the standards of industrial associations as well as government agencies.

The efforts of American railways toward standardization started prior to the formation of the Bureau of Simplified Practice, the American Railway Engineering Association being formed in 1899 at which time it created fourteen standing committees. The Committee on Water Service was one of these original Committees.

In the thirty years since its formation this Committee has done much to standardize water service materials and practice. The first Manual of the Association published in 1905 contains two and one-half pages of printed matter on Water Service problems, while the last Manual published in 1929 contains 85 pages of recommended practice on water service construction, maintenance and organization.

Many of the reports made by this Committee are suitable for standard practice and may be briefly summarized as follows:

Definition of water works terms.
General principles of water supply.
Pumping plants—steam, oil, electric.
Pumps—power, deep well.
Relative economy of steam, oil and electric pumping plants and purchased water.
Pipe lines—intake, suction, discharge, gravity.
Pipe for small service lines, including brass, copper, wrought iron, steel and cast iron.
Pump houses.
Impounding reservoirs.
Quality of water and methods of treatment.
Minimum quantity of solids which will justify treatment.
Standard method of water analysis.
Water softeners—design, maintenance and supervision.
Treated wood for water tanks.
Heating water station buildings.
Frost protection for water facilities.
Water meters.
Water department organization.
Specifications for cast-iron pipe and special castings.
Specifications for hydrants and valves.
Specifications for soda-ash.
Specifications for hydrated lime.
Specifications for quicklime.
Specifications for sulphate of alumina.
Specifications for sulphate of iron.
Specifications for wooden water tanks.

Specifications for tank hoops.
Specifications for steel sub-structures for water tanks.
Specifications for timber sub-structures for water tanks.
Specifications for steel, water and oil tanks.

A majority of railways now follow the material classification of Division VI—Purchases and Stores—American Railway Association, which covers the classification of water service as well as all other forms of railway materials. This classification was originally formulated by the Railway Storekeepers Association in 1910, and was accepted with some alterations as standard practice by the Purchases and Stores Division in 1922.

The classification of the Purchases and Stores Division for the principal materials used in water service work is as follows:

Class 3A—Cast iron pipe and fittings 3½" to 12" in size.
Class 3B—Cast iron pipe and fittings over 12" in size.
Class 9A—Fuel and water station material.
Class 42—Wrought iron and steel pipe, valves and fittings.
Class 47—Chemicals.

A questionnaire was sent to members of the Water Service Committee to ascertain to what extent standardization existed on their railways in so far as some of the principal items of water service materials were involved. Twenty-six replies were received which indicated the following conditions:

Cast-Iron Pipe and Fittings

Practically all replies favored the use of cast-iron pipe and special castings made in accordance with American Water Works Association and American Railway Engineering Association specifications. A few replies indicated the use of prepared joint cast-iron pipe for service lines 3 inches and under in size. This class of pipe is now manufactured in 1¼ and 2 inch sizes.

Wrought-Iron and Wrought-Steel Pipe and Fittings, Black and Galvanized

The replies indicated no marked preference for either of the above classes of material, the same roads in nearly all instances stating that all types were used. A few replies, however, indicated the general use of galvanized wrought-iron pipe as preferable for conveying drinking water supplies other than lime, soda-ash treated waters, this grade of pipe being less susceptible to rust incrustations than black pipe and resisting corrosion better than steel pipe.

Water Columns

Approximately 80 per cent of the replies indicated a preference for one or two makes of water column with one or two sizes of each. The balance indicated the use of several makes and sizes. Water column pits are also fairly well standardized, many roads having a standard plan for same with variations in depth to suit climatic conditions.

Oil Engines

Approximately 90 per cent of the replies indicated a preference for one make and one type of oil engine for pumping stations. A majority of the

roads also favored the use of the 15 H.P. and 25 H.P. sizes for oil engines unless the load conditions were excessive. In other words they did not favor the use of several horsepower sizes in order to bring the engine rating down to a point near the exact load requirements. A moderate excess of oil engine horsepower is desirable and the fewer sizes give the advantage of interchangeability in making repairs and replacements.

Pumps

A majority of the replies indicated a preference for centrifugal pumps rather than displacement pumps where service conditions were suitable. There are many displacement pumps still in use at railway water stations but the tendency is decidedly in favor of centrifugal pumps for new installations or where replacements of existing displacement pumps are necessary.

Steam, Oil and Electric Pumping Equipment

A majority of the replies indicated that electric equipment for pumping stations is generally preferred where the current is reliable and the cost reasonable. The steam boiler and pump still continues to be widely used for pumping but this is largely because this type of equipment endures from a previous construction period. When it is retired, it is generally replaced with oil or electric pumping units.

Where electric power is not available or is too expensive to consider, the oil engine makes a satisfactory alternate. A few replies indicated that some roads are attempting to standardize on electric motors both as regards size and make, and nearly all roads have standards for steam pump boilers.

Pump Houses

Approximately 60 per cent of the replies indicated that no standard exists for pump houses; 40 per cent of the replies indicated a standard plan for new construction with considerable variation as to size of the building and materials used; only a few replies indicated a well-defined standard plan for general use.

Tanks

Approximately 90 per cent of the replies indicated well defined standards for wooden water tanks with an average of 3 to 5 different capacities per road. The use of steel tanks is not as pronounced as wood nor are there such well-defined standards as for the latter, the manufacturers' types being usually accepted with capacities to meet the requirements for each particular location.

Chemicals for Water Treatment

All replies indicated the purchase of chemicals on specifications, approximately 50 per cent of the railways buying on American Railway Engineering Association specifications and the balance on their own specifications.

Treating Plants

The majority of the replies indicated that bids were asked on treating plants without insistence on any special type of construction. This method

provides desirable competition in construction cost and design of chemical proportioning apparatus. A considerable minority of railways have standard designs for treating plant buildings and tanks but leave the question of the chemical apparatus itself open to a bidding list of responsible manufacturers.

After giving consideration to existing practice on railways as indicated in the replies received to the questionnaire, and after considering reports suitable for simplified practice printed in the American Railway Engineering Association Manual, it is believed that the following major items of water service equipment and materials could be standardized to good advantage for general conditions:

Cast-iron pipe	Water column and pits
Wrought-iron pipe	Oil engines
Wrought-steel pipe	Pumps
Chemicals for water treatment	Wooden water tanks
Pump houses	Steel water tanks
Fire hydrant threads	Treating plants
Boilers	Packing

Standardization is continuous and other items of material, equipment, and even policy and organization may be added to the above list. It is difficult, however, to specify one manufacturer's equipment or certain sizes or types of tanks, treating plants and pumping machinery that would be fully satisfactory to all roads, owing to price, competition, climatic conditions and individual construction practice. The report is, therefore, somewhat general in character and indicates what has been accomplished in the past as well as present conditions.

Conclusions and Recommendations

(1) A large amount of data and information is available in the A.R.E.A. Manual and Proceedings dealing with water service conditions which would assist individual railways in standardizing their water service requirements.

(2) Standardization of water service materials and practice has not generally advanced to a sufficient extent. In fact, standardization of this kind except in the most obvious items does not appear to have been generally considered. It does not compare favorably with the result obtained in rail, ties, ballast and other lines of railway practice.

(3) The standardization of water service materials and practice is desirable. Where done it was found possible to reduce the amount of emergency repair parts held in stock considerably and to develop a personnel skilled in the design and maintenance of an important branch of railway work. It is recommended that railways interested give the matter serious consideration with the object of standardizing the equipment, materials and practice best suited for their requirements and suggest that the plans, sizes and types of design and equipment in use be checked with a view of eliminating those found obsolete or unnecessary.

A

Appendix D

(5) AUTOMATIC AND REMOTE CONTROL OF PUMPING EQUIPMENT

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The application of automatic and remote control to railway water supply facilities has become quite general. Actual operating experience over an extended period, on a large number of railroads, has demonstrated that such equipment is thoroughly reliable, provided same is selected, installed, and maintained in accordance with good practice. Such facilities are comparatively cheap in first cost and maintenance, hence, where provided, large annual savings have been realized, without any impairment to service. Where existing stations are revamped for such service or where new facilities are provided, accepted practice for automatic service is such that the facilities will require the attention of a reliable employee, for a short period, not more than once each day.

The object of this report is to summarize the tendency of present day practice in railway water service as regards such control. Automatic control and remote control usually are one and the same thing. Automatic control practically always involves remote control to a varying degree. Remote control sometimes does not include full automatic features, as for instance, when a station agent starts or stops a pump located some distance from station by pressing a button. Some installations are normally operated automatically for routine railway water supply purposes and at particular periods these same units are operated through strictly remote control for developing water supply for fire purposes. The general features are identical, however, so that in this report no effort will be made to separate the various classes of service.

No effort has been made to give detailed technical descriptions of the various controls, but rather a simple statement as to the various devices and the results obtained will be offered for information and reference. Similarly no attempt has been made to discuss details of installation or economies resulting from the application of such devices to existing or proposed facilities.

Automatic or remote control consists of a device designed, installed, and operated so as to perform a simple definite task. By arranging to do such a task automatically operators can be released for other duties and decided economies can thus be realized. The task which any such device is designed to do cannot generally be changed, even slightly. Being automatic it possesses the virtue of doing its particular task satisfactorily at any and all times, provided it is maintained in proper operating condition.

The fundamental consideration in design therefore is simplicity in laying out of automatic features. Complicated arrangements add to initial cost and invariably increase cost of operation and maintenance. The idea of simplicity should follow through to the device itself as regards construction and operation. Such equipment is generally installed at isolated locations where it is seldom seen by anyone save the maintainer. It is obviously good practice, therefore, to select rugged type devices, stripped of unnecessary gages, links,

coils, dials, etc. Operating conditions on all railroads make it highly desirable to standardize on types of control and methods of installation. Maintainers and supervisors are changing frequently and it is, therefore, desirable to have facilities standardized in order that they may be familiar to all employees.

Provided all other conditions are satisfactorily taken care of, there is apparently no limit as regards capacity of stations subject to remote control or automatic operation. An installation which has just been completed in the east, involves 100 H.P. motors operating on 2300 volt service; the pumping station being on a large river three miles from the railroad yard. The pumps have a capacity of 850 G.P.M. and operate at a head of 250 feet.

Operating economy practically demands storage between pumps and point of use. Usually the larger the storage the more uniform the results. Good operating results are obtained when the installed capacity of each pump is such that the unit operates collectively about 10 hours per day. The storage and arrangement of controls should be such that the number of starts and stops per day are not excessive. The policy on each particular road will dictate as to whether duplicate units will be installed complete with controls. The tendency in this respect seems to be towards single units except at very important terminals. This policy is perhaps warranted if all equipment including pump and motor is standardized. Modern practice has eliminated generally all automatic altitude valves between pumps and storage, depending on prime mover control alone to prevent overflow. In some installations, however, involving several storage units, at varying elevation, decided economy results from the use of altitude valves at each point of storage.

It is general practice to use standard power units and pumps and to arrange the wiring and piping to and from the unit, in accordance with the accepted good practice for manually operated plants. With automatic installations it is advisable, however, to place a small by-pass around the check valve located on the discharge side of the pump. This by-pass is installed as an extra precaution and will normally keep the suction flooded to the foot valve in case the latter is fouled open by small stones or sticks. It is also accepted practice to install manual cut-out switches, transformers, gages, etc., under the same standard set up for manually operated stations.

For electric prime movers, automatic and remote control is accomplished by automatic compensator starters operated through automatic controls. These may be obtained for D.C. and A.C. service. For applying to A.C. service they can be obtained for any type motor. Under the schedules filed by most power companies, motors of 10 H.P. and under may be installed without the compensator. Such small motors are controlled by across-the-line starters. This reduces materially the initial cost.

There are many automatic compensators on the market varying in principle construction, and cost. One very sturdy and satisfactory type operates on the principle of current limit acceleration being an oil immersed, completely wired, self-contained unit. It consists of a quick-break, double-throw switch, operated by a single magnet, throw-off spring and a latch tripped by a current limit relay. This compensator is wired between the motor terminals and the station cut-out switch.

There are also many controls on the market for use with the automatic compensators. They always consist of a water connection to pump, pipe

line or reservoir through which water pressure is applied to the device. This water pressure is, by various means, translated into motion between electrical contacts. The contacts are wired to the automatic starting compensator. The contacts and wirings are arranged to start the motor at low pressure and stop at high pressure or vice-versa. One very rugged satisfactory and economical type consists of a small glass tube in which are sealed the ends of the leads to the compensator. A quantity of mercury in the tube makes or breaks the circuit when the tube is tilted by changes in the water pressure. The construction is such that the desired contacts, following changes in the water pressure, are clean and instantaneous in operation. In another type, changing altitudes, in the water level, act on a helical tube spring with a pointer on the end. This pointer moves between high and low contacts. Devices of this construction can probably be controlled to closer limits.

Some railroads report the use of float switches for the control of the compensators. These can be obtained for direct and alternating current service. The float switches are complete with float and counter weight and are arranged for closing the circuit at the lower liquid level and opening it as the top level is reached. This action can be easily altered as noted below for sump pump operation by interchanging the float and counter weight. Float switches are not recommended for installations where the water, whose level is to be controlled, is subject to freezing.

Owing to the small current flow in the circuit between control and compensator it is necessary to install relays in same, if the length of the circuit is material.

There is a definite ratio between the operating limits of the control (high and low) and the pumping head. Such controls will not operate satisfactorily without some protective devices if the starting and stopping surge in the pipe line is material. Under normal conditions, therefore, a small surge tank is usually placed in the connection between control and pipe line. This surge tank consists of a small air-tight tank, the control being connected into side of same, and the connection to pipe line being into bottom. The connections themselves are complete with valves which are pinched to the minimum opening. Changes in water pressure through the surge tank, therefore, take place very slowly. Where the discharge pipe line to reservoir is very long, it is necessary for good service to place the control at the point of storage and construct a wire circuit, with necessary relays, to the automatic starting compensator.

The across-the-line-starters are self-contained units and are similar in construction to the compenstors but obviously much more simple as in their operation the prime mover is thrown directly across the power line. In most installations of compensators or across-the-line-starters, they must be complete with float switch or other control. With very small motors, such as would be found on sump pumps, the unit can be started and stopped direct with the float switch.

It is of the utmost importance to select compensators, controls and cross-the-line-starters, completed with over-load, low voltage, and lost phase protection features.

With centrifugal pumps it is absolutely necessary to obtain the best of conditions on the suction side. This includes reliable foot valves, well

screened; properly constructed suction line, and such refinements as eccentric reducers at the pump conneetion.

For important stations with high suction lift, it is sometimes necessary to install automatic primers. Two general types are available. A reliable, but elaborate and expensive type consists of a vacuum pump and float switch. These devices are located adjacent to the pump. The float is housed in a chamber connected to top of pump case and set about one foot above same. The control in this case starts and stops the motor on the vacuum pump and the float switch energizes the starting compensator for operating the main pump unit. In starting the main pump unit the sequence of events is about as follows: The vacuum pump creates a vacuum in the suction line and the pump case and up into chamber housing float. When water is admitted to the chamber the float rises by buoyancy and closes the circuit to the starting compensator through float switch. In a simpler and less expensive type automatic primer a cylindrical tank is used. This is divided transversely and is located in the suction line of the pump. The set up, valve arrangement, etc., are such that there is always sufficient water in the device to fully prime pump case and suction pipe upon starting. Such devices will operate without foot valve on the suction but this valve is in most cases installed as an extra precaution.

It is important to house all this equipment in a suitable building well lighted, drained, and ventilated. Where the building includes super-structure the same is sometimes heated electrically, using recognized automatic type space heater. A majority of the automatic stations are small and hence the cost of electric energy is relatively high so that automatic electrical heating becomes expensive. In some cases it will be found practical to heat such stations by steam. One railroad reports successfully heating of such stations by means of oil burners operated by a small furnace. The heating question should, therefore, be taken into consideration in designing building in order to obtain as nearly as possible frost-proof protection without sacrificing proper ventilation.

On some railroads the practice is to place all pumping equipment in pits, usually of the cut and cover type. By this arrangement no artificial heating equipment or expense is necessary but difficulty is often encountered in the draining of the pits. This is usually met by installing self-contained automatic operated sump pumps. The sump pumps are in general satisfactory as they are constructed and operated on the same principle as the main pumping units. One road reports successfully pumping such pits drainage by the main pumping unit. This is accomplished by concentrating the drainage in a pit and connecting the pit to the main pumping unit suction by a small pipe complete with float valve on the pit end.

One great obstacle to a more complete modernization of railroad pumping stations for automatic or remote control is lack of reliable electric service. The power companies will sometimes finance necessary extensions of their facilities if the anticipated annual power bill will give satisfactory returns. Where the return is not sufficient it can be arranged in some cases for the power company to construct an extension at the expense of the railroad under an agreement. Such an agreement usually specifies a refund on power bills for a definite period, say five years, in this way the railroad secures some advantage. This lack of electric service, however, has proved a drawback.

A large railroad in the east has met this problem by installing, as a test in an isolated location, an automatic gasoline engine driven centrifugal pump. The unit has been in service only a few months and was developed through engine and pump companies interested and if successful will be quite popular, it is believed. It can in no sense be considered as a competitor to the motor driven set. A stock four cylinder stationary type engine is used. A stock centrifugal pump is used having a capacity of 150 G.P.M. at 55 feet total head. The suction lift is approximately 8 feet. The engine and pump are direct connected through flexible coupling and operated at 1500 R.P.M. Mounted outboard of the pump and connected direct thereto through flexible coupling is a specially wound motor of proper characteristics so that the motor will crank engine at not less than one-third normal speed. At full speed the motor is converted into generator for recharging starting battery. A complete and suitable starting panel is included. The performance of this unit is being watched with considerable interest.

There are many steam pumps being operated on practically an automatic basis. One railroad has been operating for years a 5.0 M.G.D. unit at 175 feet head on a pipe line eight miles long and with less than 200,000 gallons storage. The control in this service consists of a very simple and reliable steam governor connected to pipe line and to main steam valve. A fall in pressure in the pipe line, denoting demand, causes governor to open main steam valve and speed up pump, a high pressure on the pipe line results in closing of main steam valve. Such arrangements are very satisfactory for general purposes or for fire booster systems around large terminals. When so installed a slight and constant use is arranged either by deliberate waste or by passing water through cooling jackets of various machines. The idea is to idle the main pump, when legitimate use does not exist.

In some cases we have what amounts to semi-automatic service where gas, oil, or fuel oil engines are used. All such units must be started manually. They can be stopped automatically by interrupting fuel supply or interrupting spark, by floats, controls, push button circuits etc.

Experience has indicated the wisdom of having such automatic pumping stations visited at least once each day by some local employee for inspection of equipment, oiling same, and taking care of heating and drainage facilities. At stated intervals, probably each month, skilled mechanics should inspect carefully the pumps, motors, controls, contacts, etc. The expense of installing and maintaining a recording gage with daily chart, in most cases, is warranted. Such a chart when forwarded to the proper officer will be a positive check on the daily visit of the maintainer and will indicate clearly the number of starts of the equipment and the total number of hours operated. Decided variation in these records as caused by any mal-adjustment will then be taken care of promptly.

Appendix E

(8) PROTECTION OF WATER SUPPLY PIPE LINE SYSTEMS FROM ELECTROLYSIS, WITH PARTICULAR REFERENCE TO INSULATION, PIPE BONDING, ELECTRICAL DRAINAGE AND RETURN SYSTEMS

J. J. Laudig, Chairman, Sub-Committee; W. M. Barr, J. H. Gibboney, J. P. Hanley, H. F. King. C. H. Koyl, P. M. LaBach, W. B. McCaleb, W. B. Nissly, A. B. Pierce, O. T. Rees, Dennistoun Wood.

Scope

The purpose of this report is to state briefly the important points which should be considered by railroad companies in safe-guarding their important water supply systems from electrolytic corrosion. A description of the general conditions which may lead to electrolysis and which, when recognized by the railroad, should direct attention to the possibilities of electrolytic corrosion of the water systems, will be given. Then, brief suggestions for inspecting the water pipes for electrolysis and some simple tests will be presented. Remedial measures in case electrolysis is found will be treated only in a general way.

The types of water supply systems considered in this report are the extensive water mains and laterals supplying engine terminals, roundhouses, fire mains, railroad powerhouses, etc. Small water pipe systems, unless very important, are not considered.

Pipe corrosion due to soil conditions are not covered, but only the corrosion from stray electric currents.

General Conditions Which Should Prompt Railroads to Watch Their Pipes for Electrolytic Corrosion.

If any part of a water pipe system is located very close to electric street car lines or electric railroads of any kind which use direct-current power, the pipes should be watched closely for electrolysis. Water mains crossing under electric railroads at right angles are not so liable to electrolytic corrosion as water systems paralleling the electrified tracks for considerable distances. Also, if water pipe systems are in the neighborhood of large electric cranes using direct-current power, or if they are near a large electric power plant which supplies power through direct-current transmission lines, one side of which is grounded, these pipes should also be watched, although electric railroads are a more potent source of stray currents. Even though an electric railroad may not be very near the center of a large piping system, an outlying branch pipe of the system may pass nearby or under an electric railroad and thereby furnish a path for stray electric currents to enter the system. Electrolytic corrosion is caused by electric current leaving the water pipes to enter the earth, the corrosion being roughly proportional to the amount of leakage current leaving these structures.

Inspection and Testing

If it has been decided, in view of the above conditions, to inspect a water pipe system for electrolytic corrosion, the pipes should be examined at the locations at which the corrosion is most likely to occur. These locations are at points close to other underground structures to which the current may be

leaking from the pipe system. For instance, if a part of a railroad's water supply system lies near a large water main belonging to a municipality, a portion of the railroad's pipes near this water main should be inspected. Pipes passing through cinders or filled ground (which may contain cinders or other conducting material) should be examined because this kind of soil is usually a better conductor of electric currents than some other soils. Pipes in swampy ground, salt marshes, or other exceptionally wet soil should be inspected for the same reason.

In order to examine pipes for corrosion, the earth should be removed from around the pipes for a sufficient distance, uncovering at least one or two entire pipe lengths. The surface of the pipe throughout the circumference should be washed thoroughly and examined for corrosion, which in the case of electrolysis usually takes the form of small pits spaced at irregular intervals but roughly grouped together on one side of the pipe or near a joint. If the pipe joints are leaded, the lead in the joints uncovered should be examined carefully, since lead corrodes nearly four times as fast as iron for the same amount of electric current leaving the surface. The corrosion of the lead in the joints may cause leaks in the pipe line. Electrolytic corrosion can usually be distinguished from corrosion due to soil conditions by the concentration of the corrosion on one side of the pipe or at joints.

Inspections of this kind should probably be made at intervals of not more than a year. Different pipe lengths can be examined at different inspections in order that the periodic examinations may cover a wider area.

If electrolytic corrosion is suspected, some simple tests should be made to verify it. It may be desirable to make the tests at the same time as the inspections, or at more frequent intervals than the inspections. The tests may give indications of the best locations for inspection. If a street railway or electrified railroad is involved, it may be well to notify the Electrical Engineer of the electric railway that electrolysis is suspected and he will probably co-operate in the tests or make independent tests. In general, the Electrical Engineer of the railroad company would be better equipped to conduct the electrolysis tests than the Water Department of the railroad.

Some simple tests which may be made require only a direct-current indicating voltmeter specially designed for electrolysis testing. A high-resistance instrument is required. An additional voltmeter of the recording type would be valuable in order to make 24-hour readings. The voltages between the pipes and adjacent structures, such as other pipe systems, should be measured with these instruments. If the indicating voltmeter is used, these tests should be made during the morning and evening rush hours of the electric railroad involved, or during the operation of the power plant or electric crane, if either of these is the source of the stray current. In making contact with the pipe or adjacent structures the contact electrodes attached to the voltmeter leads should be of the same material as the pipe or structures that they are to make contact with in order to minimize voltage indication from galvanic action. Voltages should also be measured between pipes and iron ground rods (iron rods if pipes are iron) spaced at 100 feet or more from the pipes. These measurements should be made with the ground rod first on one side of the pipe and then on the other. A voltage indication showing that the pipe is positive to earth or an adjacent structure indicates that current may be leaving pipe for the earth and causing corrosion, provided the voltage indicated

is sufficiently high. A voltage of 0.1 volt or less should not be taken as a definite indication, but if an average voltage greater than 0.1 volt is indicated, electrolytic corrosion should be watched for. If a 24-hour voltage chart is made with a recording voltmeter, the algebraic average voltage should be taken as the indicating voltage. If the voltage rapidly fluctuates from plus to minus, electrolysis may not be indicated, even though fairly high momentary voltages may be recorded. A report of the American Committee on Electrolysis makes the following statement in regard to reversing polarity:

> "Where the polarity of the pipes reverses with a period of only a few minutes, it has been shown by extensive experiments that the corrosive process is in large measure reversible, and the actual amount of corrosion comes more nearly being proportional to the algebraic average of the applied potential than it is to the arithmetical average during the total time the pipe is positive. In all cases, therefore, where the polarity of the pipe is continuously reversing and the period of reversal does not exceed five or ten minutes, the algebraic average of the voltages or currents should be given far greater weight than the arithmetical average values during the positive period."

If it is found by inspection that corrosion of pipes is so extensive that some of the pipes must be replaced, a sample of the corroded pipe surface and surrounding soil may be sent to the Chief Chemist of the railroad, who should analyze this material. The composition of the soil and the material on the corroded pipe surface will give an indication as to whether corrosion is electrolytic or due to soil conditions.

Pipe corrosion can be caused by stray currents flowing through the earth laterally with respect to the pipe, in which case the corrosion will be fairly uniformly distributed on the side of the pipe in the direction of current flow. If corrosion is found to be concentrated in one or two small areas of pipe surface, current may be flowing in the pipe itself and leaving at the point of corrosion. If this condition is suspected, verifying tests can be made by measuring the voltage drop in a considerable length of the pipe on each side of the corrosion. If the voltmeter indicates current flow in the pipe from two directions toward the corrosion, electrolysis is indicated, or if the voltage drop per foot length of pipe is much greater on one side of the corrosion than the other, in a ratio showing that current is leaving the pipe, electrolysis is indicated.

A study of the voltage fluctuations observed during electrolysis tests may serve to identify the source of the stray electric currents. Electric railroads cause typical fluctuations easily identified, with starting of cars or trains. Simultaneous observations, during electrolysis tests, of electric train movements, in the neighborhood, operation of electric cranes, or other suspected sources of stray currents, would probably reveal the origin of the current.

Since the intensity of discharge of current from any portion of a pipe line is the factor most directly related to the rate of corrosion, the determination of the direction and density of the current in the earth surrounding the water pipes is a most important test for establishing that the pipes are in danger from electrolysis. The national Bureau of Standards at Washington, D.C., has developed an instrument called the "Earth Current Meter," which can be used to measure the density of the current in the earth surrounding the pipe. The direction of the current, of course, can be determined by the

voltmeter, which is part of the instrument. The test with an earth current meter generally requires excavation of a trench at the point of test, but these excavations are desirable for another reason, that is, inspection of the pipes. The current density surrounding a water pipe can be measured by the earth current meter by taking readings in the earth on all sides of the pipe. Such a series of measurements would establish whether the earth current is flowing outward from the pipe or whether it is a lateral flow passing the pipe, and also whether the current density is greater on one side than another, a condition which would concentrate the electrolysis on one side of the pipe. A description of the earth current meter and a discussion of its uses may be found in the Bureau of Standards Technologic Papers 355 and 351, obtainable from the Superintendent of Documents, Government Printing Office, Washington, D.C. Briefly, the earth current meter is based upon the principle that the density of current flowing between two points in a homogeneous soil can be calculated from the earth resistivity and the voltage gradient between the points.

Remedial Measures

If it is evident that electrolytic corrosion is due to a street railway or electrified railroad, it may be possible to arrange for the installation of a copper cable connecting the pipe system with the negative bus of an electric railway substation, if one is nearby. This cable will "drain" the stray current from the pipe system, and, if properly designed, will lower the voltage of the pipes below that of the earth, thus preventing current leakage into the earth and therefore preventing electrolysis. If the substation is not near, a drainage connection may be made to the electric railway running rails (or impedance bonds connected to rails), if tests prove it to be advantageous. If such drainage cables are installed, a careful check should be made at regular intervals as to the amount and direction of the current in these cables. In some cases, it may be found that at times the current in the drainage connection will reverse, that is, flow from the electric railway substation bus or rails into the water pipes. Such a condition would occur at periods of no load or light load on the substation. This current flowing in the opposite direction from that desired would be a cause of electrolytic corrosion on the pipe system, if it left the pipes to the earth in any place. In order to prevent this reverse current, it may be desirable to insert an automatic reverse-current relay and switch in the drainage connection, which will open the circuit whenever there is a tendency for the current to reverse. If a part of the water-piping system near the drainage connection happens to be partly in a dry soil territory or laid on top of the ground so that its electrical resistance to earth is comparatively high, it may be well to install a fuse in the drainage connection in order to prevent high voltage or high currents from entering the piping system in case of short circuits on the electric railway. The size of this fuse should be determined by making it slightly larger than sufficient to carry the drainage current under normal conditions.

No such drains should be permitted until the Water Service Department has approved them, based on report by the Electrical Engineer, reciting existing conditions, hazards, etc., and accompanied by a plan showing the complete drainage system as recommended by the Electrical Engineer. The installation should include ample facilities for making frequent and complete

tests. Should such tests, made subsequent to the installation of the drain, indicate improper operation or increase of current flowing, it will usually be found necessary to discontinue the drain or modify it.

The insulation of pipe surfaces by means of covering the pipes with asphalt or other insulating material is not always satisfactory, since only extreme care in applying the pipe covering can prevent pin holes in the covering. Holes in an insulating covering concentrate the leakage current and will accelerate electrolytic corrosion in the neighborhood of these holes.

Insulating joints in pipes will prevent current flow along the pipes, but will not prevent corrosion due to lateral flow of stray currents. Insulating joints at only a few carefully selected locations in the pipe line may reduce current flow but will not prevent it entirely, and corrosion may be found concentrated at points closest to the insulating joints.

Electrolytic corrosion may be reduced by burying old cast-iron pipes parallel with the attached pipe and bonding these so-called "deadmen" with copper cables to the pipe lines, taking the corrosion on these old cast-iron pipes or "deadmen." The "deadmen" should be placed on the side of the good pipe in the direction of the current flow from the pipe at place where electrolysis is suspected.

Appendix F

(10) CHEMICAL CONTROL AND GENERAL SUPERVISION OF WATER TREATING PLANTS

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The results to be expected from a general water improvement program are determined to a considerable extent by the chemical control and general supervision of the water softening plants. With the already large and the rapidly increasing investment in these facilities, together with the influence of results on movement of train and condition of boilers, the importance of accurate and constant control and supervision is being more and more appreciated.

In order to determine the present practice a questionnaire was sent out and information on present practice was obtained from 24 railroads. Tabulation of the answers follow:

1. Do you have centrally located water laboratories with water samples furnished periodically?

   Central laboratories are maintained with periodic water samples furnished for the control of water treating plants by 15 railroads.

   Periodic samples for complete and special test are furnished on 2 roads. Samples not furnished a central laboratory periodically on 7 roads.

2. How often are samples furnished the laboratory?

   The period for the furnishing of samples varies from semi-weekly to tri-monthly. In special cases, such as at important terminals or at points where water quality fluctuates rapidly, daily or even shift examinations are made. In most cases where laboratory control of treatment is an important factor, samples are furnished semi-weekly or weekly. Tabulation of answers follows:

Period	*Number of Railroads*
Semi-weekly	7
Weekly	5
Bi-weekly	1
Monthly	3
Tri-monthly	1
Irregular, special, or none	7

3. Has testing and change of formula by treating plant operators proved successful?

   This was reported as successful by 6 roads, as unsuccessful by 8, and as favored in special cases only, or as never having been tried by the other 10 roads reporting.

4. What methods are used for testing and how are records and reports made? Please furnish copy of special forms used.

   The methods for testing given in the Manual of The American Railway Engineering Association, are used in most cases. A few water service engineers and chemists report that tests are made and results expressed on the basis of parts per 100,000 instead of in grains per U.S. gallon. The routine periodic tests include raw and treated water tests for hardness, alkalinity, and causticity. Sodium chloride and dissolved solids tests are made, on some railroads periodically, on the raw, treated, and boiler water samples. These last tests are for check and control of boiler water concentrations. Test for free CO_2 is made periodically in special cases on some roads.

   Though there was a considerable difference in the forms furnished, yet the forms covered, insofar as information supplied was concerned, substantially the same subjects. Reports and records included—1st, forms furnished inspectors and chemists by the plant operator showing water pumped and treated, chemicals used and on hand, etc.; 2nd, forms used by chemist and inspectors in maintaining records of plant inspections and periodic tests; and 3rd, forms used by the chemist and water service engineers for reporting results of treatment, cost of treatment, savings effected, etc.

5. How many inspectors do you have and state average number of plants per inspector?

   The number of plants per inspector varies from three to forty-five. This apparently great difference is due mainly, as indicated by the answers given, to three things: 1st, accessibility of plants; 2nd, the large number of so called wayside plants handled per inspector, and 3rd, to the greater number of inspectors necessary where control is obtained through inspections without periodic samples sent to a central laboratory.

6. List conditions requiring special attention.

   These include the analysis of chemicals used for water softening, investigation of new supplies, clarification of water where difficulty is encountered in removal of suspended matter, check of internal boiler treatment, check of foaming complaints and the use of anti-foaming compound, regulation and check of boiler blow down, and the investigation of boiler complaints attributed to water conditions.

The answers to the questionnaire indicate that from the standpoint of chemical control and supervision the problems encountered by the departments in charge of water treating plants come under two general classifications, the furnishing of a properly softened and clarified water, and the check and control of the treated water in the locomotive boilers.

The chemical control of the water softening plant is effected both through periodic water samples furnished a centrally located laboratory and through examinations at the plant. In most cases both methods are used. However, in

a few cases the chemical control of plant operation was obtained only by means of plant inspections. It would appear that the use of periodic laboratory samples, in conjunction with check on the ground, gives a more complete record and control of the water furnished for boiler use. The time interval between sample periods should be short enough that close touch with the situation is maintained. Semi-weekly sample periods with daily samples from important points appear to be favored. A very considerable increase in the number of chemists or inspectors employed would be necessary to give the same complete record and accurate control given by the use of both systems in conjunction.

Another outstanding difference in systems for plant control is that tests and formula adjustments are made by pumpers on some roads, while on others this system is not looked upon with favor. In the majority of cases these tests are only used under unusual conditions.

Laboratory control cannot be depended upon exclusively. Even the most simply designed plants have mechanical features and a chemical proportioning equipment that needs frequent check and inspection.

Accuracy of water analyses and check of strength of chemicals will not produce expected results unless the plant functions correctly. Check is usually necessary of the plant operator as well as mechanical equipment.

In addition to the routine tests used for periodic water analyses, special laboratory tests are made from time to time. Complete analysis are made of new supplies or of old supplies which fluctuate in quality. Hydrogen ion determinations are being made experimentally, since the range of the colormetric method has been extended to include waters of high caustic alkalinity. This determination is used not only in the study of removal of suspended matter, but also in studying pitting and corrosion.

Clarification of water supplies constitutes a special problem. Although the clarification of many supplies is easy of attainment, others require special attention. It has been reported recently that the dissolved solids present in a water are an important factor in coagulation and that the clarification results are controlled to some extent by these solids as well as by hydrogen ion concentration. This means that each supply is a special problem and requires individual study in the laboratory and at the plant to determine the most economical and effective kind and amount of coagulant. Jar tests may be conducted in the laboratory to determine best coagulating conditions. Instructions for conducting jar tests emphasize the importance of proper agitation. Mechanical agitation at a speed of 30 to 40 revolutions per minute is usually recommended. By ordinary shaking or violent agitation the flec formation is broken down and results obtained are not accurate or typical.

One of the important duties of the water chemist or inspector is the coordination of treating plants results with the performance of the water in the locomotive boiler. On some roads boiler water tests are made periodically. These tests are made not only for check of treatment results, but also for control of foaming, use of anti-foaming compound, and boiler blow down. For the regulation of the blowing down of boilers, dissolved solid tests give the boiler water concentration. After the concentration at which foaming occurs, has been determined, this test may be used to determine the increase in dissolved solid concentration over the engine district and amount of blow-down

necessary can be calculated. The sodium chloride, dissolved solid ratio, gives a means for rapid check in the field of boiler conditions.

The information furnished in the answers to questionnaire indicates the wide variation in means of effecting this control under the varying conditions encountered on the different railroads. Regardless of the system in effect, the success of a general water improvement program depends largely on adequate chemical control and supervision of the water softening plants, the expense for which is usually much less than the cost of failures and possible interruption to traffic movement. The individual needs on the respective territories require special consideration to determine the most economical means of best handling the local conditions.

Appendix G

(11) PROTECTION OF BOILERS AND BOILER MATERIALS FROM CORROSION AND DETERIORATION WHILE IN STORAGE

D. A. Steel, Chairman, Sub-Committee; Armstrong Chinn, J. H. Davidson, R. L. Holmes, P. M. LaBach, J. J. Laudig, E. M. Miller, O. T. Rees, R. A. Tanner.

The protection of boilers and boiler materials from corrosion and deterioration while in storage may not at first seem a subject of concern to this committee. The selection of the materials that enter boiler construction, and their application and use, is the work of railway mechanical departments, and their storage and handling prior to application, the work of the mechanical and stores organizations. It is not the desire or interest of this committee to assume for engineering forces any powers or responsibilities which are exercised by and should belong to other forces. The committee has become interested in the subject of boiler and boiler materials in storage, in consequence of the attention this association has given to the problems of providing harmless water supplies for use in boilers and the authority vested in the committee by the American Railway Association to investigate and report on all causes and conditions which tend to aggravate or to simplify the troubles associated, or thought to be associated, with the use of impure water in steam boilers and their appurtenances.

One of the troubles associated with the use of water in boilers, both locomotive and stationary, is corrosion. The interior of the boiler shell, the exterior of the firebox, the exterior of the boiler tubes, the staybolts and crown bolts and all other metal surfaces exposed to boiler water are subject to it. The corrosion may occur as rust or in the more aggravated form of pitting and grooving. Pitting and grooving have demanded first attention, but rusting is not so lightly overlooked. Whatever the form, corrosion is waste. It is recognized as one of the greatest sources of waste in industry and is particularly to be guarded against in boiler materials.

Most railways expend large sums annually for these materials, both because of the large amounts used and the high grade of material required. Between seven and ten million dollars are expended each year by the Class I railways for boiler tubes alone. Corrosion is a direct out-of-pocket loss to

the purchaser in so far as the railroads are deprived, by corrosion, of all the metal purchased.

Corrosion also increases the cost of maintenance. Strength is an important factor in boiler metals. It determines the ability of the material to withstand the increasingly high pressures under which power is required to operate and also the strains resulting from variations in boiler temperatures and train movements. By reducing this strength and shortening the life of the materials, corrosion increases the cost of repairs. The expense of renewing boiler tubes and sheets is large whether the problem is one of renewing a few tubes in a roundhouse or an entire set in a shop. The cost of repairing fireboxes and boiler sheets is much greater. Usually the jacket must be removed and the motion work dismantled. From purely maintenance considerations, all corrosion that may possibly have a weakening effect upon these boiler materials should be avoided.

Where corrosion occurs to an appreciable degree, its tendency is also to increase operating costs. Always when repairs are required, the power is taken out of service and, when tubes are punctured by pitting during service, they cause fuel losses by allowing steam and water to reach and cool the fire. Often they also cause serious delays to train movements, if not complete failures. The importance of these considerations has grown larger with the increasing tonnage of trains, the increase in the length of locomotive runs and the reduction of helper and relief service.

Added to these considerations, and largely responsible for the higher prices paid for boiler material, is the question of safety. The aim in boiler construction is constantly to use as little metal as possible to reduce weight. In connection with fireboxes and flues and other metals through which heat is transmitted in generating steam, the desire is also to keep down the thickness of metal to a minimum, in order to avoid heat losses. At the same time, safety is paramount. The locomotive boiler under the high pressures of the present is a source of great potential danger. Explosions demolish equipment and are equally disastrous to life and may cause other losses in single instances that offset the economies of design, close buying or efficient handling. The reputation of a railroad for safety in operation also hinges upon its freedom from such accidents or the likelihood of such accidents. The strength and other qualities of material in boilers must not be permitted to become weakened by corrosion, if such hazards and accidents are to be prevented. In this respect, the avoidance of corrosion is decidedly in keeping with the slogan of "Safety First" in present railroad operations.

The corrosion in operating railway steam boilers has received much study and is being attacked from various angles. Attention is being given to the selection of water supplies free from corrosive tendencies. Attention is also being given to such treatment of troublesome waters or to the control over the use of such waters as will reduce their injurious effects. The expense entailed in this direction, both in the research involved and the methods pursued, has been considerable, but the fund of knowledge has been greatly enlarged upon and the progress made by those who have been able to interpret and apply properly that knowledge has been gratifying. Attention has also been given to the chemical and physical structure of boiler materials and even to their arrangement within boilers in order to render them resistant or to protect them from corrosion during use.

The Committee finds, however, that no attack upon the problem of boiler preservation is complete without considering the care received by boiler materials during their handling and storage, particularly in territories where corrosion is common. Undue rusting and also surface scoring and other deformations in the metals should be studiously avoided. This precaution should be taken not only while new boiler materials are awaiting application but also while power is stored and when handling second-hand materials. Rusting, nicking or distortions of vital parts may so reduce the cross sectional area or alter the structural character of the materials as to weaken or render less certain their strength in the vital work they are designed to do. Rusting of boiler materials and their scoring or distortion in handling, moreover, not only reduces the amount of metal available in the boiler to withstand the rigors of corrosion, but are believed, from present knowledge, to render them less resistant to corrosion if not actually to accelerate corrosion when in contact with corrosive waters.

The seriousness of these effects results from the fact that a boiler shell or boiler tubes or fireboxes are no stronger than their weakest part and that pitting will frequently attack the weakest spot and cause the complete failure of an otherwise sound piece of material.

In studying the conditions under which boiler materials are handled, the committee has inspected many points of storage and has collaborated with the Mechanical and Purchases & Stores Divisions of the A.R.A. and presents the results of its investigations as follows:

Storage at Point of Shipment

Practically all boiler materials with the exception of staybolts and crown bolts, which some roads make in their own shops, are purchased in finished form. Their protection from corrosion or injuries likelp to promote corrosion should, therefore, begin at the factory. Most roads have taken the precaution to guard against irregularities in thickness or size, or defects in composition likely to affect the strength of the materials, by appropriate clauses in their specifications, but those conditions or methods of handling that have a bearing on corrosion have not been emphasized. The Committee believes that railroads should expect manufacturers and other dealers to so handle and care for boiler plate, firebox steel, boiler tubes and other boiler materials as to protect them from rust or other injury, not only up to the time of inspection, but up to the point of shipment, and it is recommended that the following clause, or one of similar import, be inserted in all specifications for that purpose:

SPECIFICATIONS

It is further required of the manufacturer or dealer that the materials covered by these specifications should be cared for and handled following their manufacture in such a manner as will, in the judgment of the inspector, protect them from corrosion, scoring or other injury up to the time of delivery and it is understood that such scoring or other injuries occurring between the time of inspection and shipment will be sufficient cause for subsequent rejection at the seller's expense.

The Committee has investigated the question of coating these materials to protect them from rust, preparatory to shipment. Some roads do not favor

the practice on the ground that coatings hide surface imperfections. Other roads require manufacturers to apply a coating, particularly in the case of boiler tubes. The Committee endorses the opposition to the use of any coatings that will prevent the proper inspection of the material. It should also be known that some coatings, such as kerosene, accelerate corrosion in themselves and that the use of heavy oils, by reason of their heat-insulating properties or tendency to emulsify in the boiler, are likely to cause a variety of boiler troubles unless removed before the materials are used. Where the atmospheric or other conditions are such as to favor the use of coatings.

A paint reducing oil properly thinned or approved protective coating should be applied.

When oil or other coating of boiler materials is prescribed, the specifications should withhold its application as far as practicable until after inspection of the boiler materials, and the composition of the coating should also be tested.

Materials in Transit

The rapidity with which deliveries are usually made at present reduces the risk of injuries to boiler materials during transit. The possibility of rust and other damage while in transit should be kept in mind, however, and guarded against. With the exception of staybolts and crown bolts, such materials, for the sake of convenience in loading, are usually shipped in open cars. Where the conditions of the shipments are likely to result in considerable rusting, the use of oil free from corrosive qualities and which can be subsequently removed without undue expense may be advisable. Shippers and freight handlers should be advised against subjecting the materials to sharp blows that may bend or cut, and, in all instances, the receivers of such freight should observe the loads for evidences of such injury and lay the damaged material aside for examination. This inspection should particularly be assured where the material in transit has been wrecked, and the use of boiler tubes as levers, etc., should be avoided.

Unapplied Material in Storage

The Committee particularly desires to stress the importance of protecting boiler materials from corrosion or other injury while in storage or awaiting application. The cost of boiler materials to railroads has been needlessly increased and the life of boiler materials prematurely shortened by a failure to appreciate this. The Committee has been more impressed with the attention given by custodians to the arrangements made for convenient and economical handling of boiler materials and to their orderly and presentable appearance than to their protection. In shelter for boiler materials is sometimes inadequate or lacking in places where unfinished castings, little subject to deterioration from corrosion, enjoy such protection. Deplorable rusting has been observed in exposed stocks, and this rusting has not been confined to uncoated stocks but is commonly found in the lower sections of piles which have been painted on top, apparently for the sake of appearance. The Committee mentions these conditions with full knowledge that excellent provisions have been made at some points for the care of boiler materials while in storage and believes that shop forces have often been at fault in affording adequate protection to boiler materials as well as the store forces, but emphasizes that,

in meeting the corrosion problem, the existence of these conditions should be recognized where found and avoided as far as practicable.

Store departments should order, and purchasing departments contract for, the smallest quantity of boiler materials consistent with current needs and economical purchasing and loading in order to avoid accumulations that cannot be adequately sheltered and to avoid exposure over long periods.

As far as possible, adequate shelter should be provided for all boiler materials. Heavy investments are not necessary, but such shelter should have a watertight roof and should preferably be completely enclosed, and the interior of the buildings should be free from dampness.

Where shelter is out of the question, all boiler materials should be stored so as to shed water and to allow the free circulation of air over all surfaces. In the case of boiler steel, this can be accomplished without interfering with convenient handling by setting rows of rails vertically in concrete so that the boiler plate can be set on edge above the ground. A modified form of such a rack is equally suitable for storing tubes in sets, where they will drain and can also be lifted bodily by crane. It is particularly important that all tubes and plates should be stored to permit using the oldest stock first. The Committee emphasizes in this connection that a high rate of turnover may mean little in handling boiler materials from the corrosion standpoint and may even be misleading unless the average rate truly represents the actual movement of units. Where rains are frequent, the layers of tubes should preferably be separated by non-metal strips to facilitate drainage.

Where unsheltered tubes may be in stock over extended periods and much wetting is unavoidable and the region one where boiler corrosion is encountered, they should also be protected by coating. A non-corrosive oil is preferred to varnish, excessive applications should be avoided, and the oil should be cleaned off before the materials are used.

Care should be exercised when transferring stock of boiler materials from one point to another and in delivering to users at shops to protect them from dents, cuts or bends, and all handlers should avoid using the materials in ways that may cause such injuries, for example, the use of tubes as fulcrums, levers, etc., and the use of boiler plates as a surface on which to chisel cutting and welding work, etc. Any boiler material showing extended corrosion or injury should be held for inspection before being used.

Making Ready for Use

In regions subject to boiler corrosion, boiler forces should be given to understand that rust, pits, dents and other scoring of boiler materials, and also surface oils, may promote corrosion or other troubles in operation and should be removed before the power is placed in service. Boiler plate and tubes should be inspected for pits and the precaution taken to assure that all deposits in these pits are removed and the cavities filled. This is usually accomplished in a satisfactory manner by spotwelding. Since the punching of bolt holes in boiler plate has been found to promote corrosion as a consequence of strains set up in the physical structure of the metal, the practice of drilling holes should be followed as far as practicable. It is also important from corrosion standpoints, as well as from renewal considerations, to avoid as far as practicable mixing second-hand tubes with new tubes, and particular care should be exercised to remove from the interior of the boiler, nails, bolts

or other loose pieces of metal because of their effect in promoting corrosion at points of contact with the boiler metal.

Where boiler tubes have been varnished or oiled in storage and such coatings have not been removed before application, cleaning should be insisted upon in territories of troublesome waters before the power is released for service. The total amount of this oil on a set of tubes is large. In scaling waters, a common effect is to increase the tenacity with which the scale adheres to the tubes and, even where it is eventually removed under boiler operation, the tendency is to cause overheating of the metal by preventing the water from coming in contact with the steel. The oil may also combine with foreign matter in the water to form a scum which promotes boiler foaming or collects in steam outlets while compositions which disintegrate under the heat are likely to promote corrosion. Troubles of this character may usually be avoided by washing the boiler with soda-ash.

The soda-ash should first be dissolved in warm water and applied by removing a plug from the top of the boiler and pouring in the mixture through a funnel. This is preferably done in connection with the preparations for steam testing. The boiler should be fired up and the steam pressure raised to the allowable working pressure. The boiler should then be blown down and cooled and then thoroughly washed to remove any sediment caused by the use of soda-ash.

Locomotives in Storage

The Committee believes that no report on the protection of stored boiler materials from corrosion covers the problem without taking into account the stored or out-of-service locomotive and power plant boiler. The stored locomotive is usually overlooked, but it is probably the greatest of all sources of corrosion occurring under atmospheric conditions. Stored boilers containing corrosive water are less subject to the water when cold than when it is hot, but other conditions necessary to corrosive action are unchanged and may even be accentuated as by the lack of periodic cleaning to remove corrosive deposits.

After the boiler is emptied, it may still be damp and unable to dry because of its enclosed condition. Under such conditions, rusting can take place and be aggravated by sweating during warm weather. Any corrosion taking place, moreover, is quite likely to proceed unhindered because it is not detected, as would be the case if the surfaces were exposed to view. As a result of these conditions, it is not uncommon to find progressive deterioration in boilers that were in good shape when stored. Instances have come to light where the tubes in many boilers have been completely ruined during the storage period. It is conservative to state that a large amount of money is lost each year from corrosion of this kind. Since most railroads find it necessary to store some of their locomotives each year over considerable periods, the protection of these boilers should receive careful attention.

There is no universally accepted method at present of protecting stored boilers from corrosion. This results from the fact that the form and intensity of corrosion, as well as climatic conditions, vary in different sections. The ideal precaution is to empty the boiler while the surfaces are still hot and remove all plugs to permit the boiler to dry thoroughly. Where a dry boiler cannot be assured because of atmospheric or other conditions, it has been

suggested that powdered soda-ash be blown into the boiler until all surfaces have been dusted with it. One road reports satisfactory results from this practice. Boilers cannot be left filled with water during storage where freezing temperatures are encountered, but in the warmer climates it may prove more convenient and equally satisfactory, where corrosion is feared, to give the water in the boiler a heavy dosage of soda-ash or other inhibitor using about 50 pounds to the boiler. In all cases, stored locomotives should be inspected periodically if corrosion is suspected and should be thoroughly washed with water containing soda-ash before the equipment is again placed in service. It is suggested that the method of washing, described under "Making Ready for Use," be used for this purpose.

Conclusions

The Committee summarizes its report with the following conclusions and recommendations:

(1) Railroads are experiencing appreciable corrosion in boiler materials while in storage.

(2) This corrosion is not only detrimental to the material, and dangerous, but may interfere with other corrosion-prevention work.

(3) Thorough protective work requires the proper exercise of care of all boiler materials prior to shipment, during transit, while being handled and stored at storehouses and while being prepared for application and while power is stored.

(4) Proper protection of such material from corrosion is not altogether a technical problem, but a problem of educating all forces handling the material to appreciate that corrosion of these materials is detrimental and securing their co-operation in rust avoidance wherever boiler materials are involved.

(5) Purchase specifications should include clauses requiring manufacturers to protect boiler materials from rust or other corrosion prior to shipment.

(6) Protective coatings are permissible where extensive corrosion in storage in transit is unavoidable, but in all cases the substance used should be non-corrosive and removed before the materials are placed in service.

(7) It is equally important in corrosion prevention to avoid dents, cuts, kinks, or other injuries to boiler materials as well as to avoid rusting.

(8) All boiler materials should be kept dry while in storage by adequate provisions for shelter, drainage, and free circulation of air.

(9) Boiler materials should be stored to permit using the oldest stock first, and a high rate of turnover should be maintained.

(10) The mixing of second-hand tubes with new tubes in boilers and the mixing of tubes of widely differing composition should be studiously avoided.

(11) Stored boilers should be preserved by adequate drying of the interiors, or by using suitable inhibitors and they should be periodically inspected for evidence of corrosion.

Appendix H

(12) PROGRESS BEING MADE BY FEDERAL AND STATE AUTHORITIES ON REGULATIONS PERTAINING TO DRINKING WATER SUPPLY

A. B. Pierce, Chairman, Sub-Committee; W. L. Curtis, C. H. Fox, W. P. Hale, L. A. Henry, J. R. Hickox, R. L. Holmes, H. F. King, H. L. McMullin, H. E. Silcox, H. W. Van Hovenberg, J. C. Wallace, A. E. Willahan, Dennistoun Wood.

We were advised by the United States Public Health Service in their letter dated July 9, 1930, as follows:

> "At the present time no changes in the interstate quarantine regulations are being considered. With the completion of the work of the Joint Committee of the American Railway Association certain changes in the regulations will be recommended."

R. C. Bardwell, H. W. Van Hovenberg and A. B. Pierce represent the American Railway Engineering Association on this Joint Committee.

For several years the following subjects have been under discussion and studied by this Committee: Car Water System, Car Water Filter Pipe, Car Water Filling Pipe, Water Coolers, Car Water Filter, Car Toilet and Lavatory, Water Bucket, Sanitary Facilities of Coach Yards, Water Hose, Soil Cans, Handling Ice, Hydrants, Waste Disposal, and Coach Yard Platforms.

During 1929 and at a meeting held June 11, 1930, the following sections of the proposed Manual on Railway Sanitation were approved by the Joint Committee: Car Water Systems, Car Water Filling Pipe, Water Coolers, Car Toilet and Lavatory, Water Bucket, Sanitary Facilities of Coach Yards, Water Hose, Soil Cans, Handling Ice, Hydrants and Coach Yard Platforms. The recommendations approved by the Joint Committee were not made until an extensive questionnaire was sent out to the Chief Operating Officers of all Class 1 Railways and their answers carefully summarized and compiled.

The Medical Section and Mechanical Division of the American Railway Association have also approved the above sections.

Committee XIII—Water Service and Sanitation, has approved the following sections: Water Coolers, Car Toilet and Lavatory, and Soil Cans. Sections on Sanitary Facilities of Coach Yards and Coach Yard Platforms have received tentative approval by the Committee pending endorsement by Committee XIV on Yards and Terminals. Section on Hydrants is being given further consideration, as is also tests on car filling pipe.

Through the Joint Committee extensive test was made this year of the methods used in cleaning removable coolers and soil cans. The test was made by the Illinois Central, Chesapeake and Ohio, Richmond, Fredericksburg and Potomac and the New York, New Haven and Hartford Railroads, with the result that steaming was found to be of no special benefit from a sanitary viewpoint and flushing with portable water is now considered satisfactory.

In the last year the United States Public Health Service inspected several railroads from a sanitary standpoint. A detailed report of their findings was sent to the various roads thus inspected, not only criticizing existing sanitary

conditions but recommending that a trained sanitary engineer be detailed to study sanitary conditions co-operating with the Joint Committee. Most of the roads receiving these reports have made a survey of existing sanitary conditions with the idea of making improvements as far as possible along the lines thus recommended by the United States Public Health Service.

Appendix I

(14) METHODS OF LAYING CAST IRON PIPE AND SPECIFICATIONS

F. D. Yeaton, Chairman, Sub-Committee; C. H. Fox, J. P. Hanley, P. M. LaBach, R. A. Tanner, W. A. McGee, H. E. Sillcox, W. B. McCaleb, A. E. Willahan, J. H. Davidson, R. N. Foster, F. P. Turner, H. F. King.

General

Methods of laying cast iron pipe and preparing complete specifications are closely related to and involve the subject of the design, construction, and maintenance of pipe-lines. The Water Service and Sanitation Committee has previously given consideration to certain phases of this subject.

The following reports relating to this subject have been published by the Association:

Relative Merits of Cast-Iron, Steel, Wood and Other Materials for Pipe Lines—1923 Proceedings.

Specifications for Contracting Water Service Work—1923 Proceedings.

The use of Lead as Compared with Substitutes for Joints in Cast Iron Pipe—1925 Proceedings.

The Design, Construction and Maintenance of Pipe Lines—1926 Proceedings.

Map and Profile

An accurate map, profile and detailed drawings should be prepared showing the location, alinement and grade of the pipe line, the size and class of pipe, the radius and length of each curve, location and amount of angles and bevels, the position and size of valves and other appurtenances. The various sections of pipe and the special forms should be numbered to correspond with the location on the map so that they can be readily sent to their proper places.

Stakes should be set by the railroad company's engineer for the line and grade of the pipe line before trenching operations are commenced. The Contractor should be required to protect the stakes and use particular care to adhere to the established lines and grades.

Trenching

Trenches for water pipe are not usually deep enough to require bracing or sheeting, the depth being from four to six feet or sufficient to give the necessary covering for protection and to place the pipe below the frost line. In the Northern tier of States and Canada greater depth are sometimes necessary. Where pipe lines cross high ridges extending above the hydraulic grade line deep trenches may require sheeting and bracing. In wet ground

it is usually advisable to open only short sections of the trench at a time. In rock the trench is carried several inches below the proper grade and the space refilled with fine material to give the proper bedding for the pipe. Bell holes for cast iron pipe should be excavated wide enough to allow sufficient room for making the joints.

Trenching machines are generally used in connection with the laying of long lines of pipe. These machines are usually driven by steam or gas engines and are designed to cut a trench about 24 inches in width and up to ten feet in depth. The back filling of the trench may be by means of a scraper operated by a small gas engine mounted on a truck.

Foundation

If the ground is unstable or too soft to give a good bearing, it may be necessary to use an artificial foundation to keep the pipe in place during construction and hold it rigid against unequal pressure. This may consist of concrete blocks placed on stringers or of piling with caps on which the pipe may rest.

If the pipe is full of water, it will weigh but little, if any, more than the soil displaced, so that there is not much tendency for it to settle after the back-filling has become compact. For large valves and heavy fittings, foundations of concrete may be used to advantage.

Material

Cast iron pipe is extensively used for water-pipe lines. The bell and spigot type has been in use for many years. Other forms of joints or couplings are now coming into more general use.

A type of cast iron pipe having an iron-to-iron joint, consisting of a shallow conical hub and a corresponding short conical machined spigot, can be obtained in many sizes. Each hub and spigot has a pair of bolt lugs for ordinary pressure and two pairs, equally spaced, for high pressures. No packing, gasket, lead or caulking is required, and joints are quickly made. Pipes can be readily bolted together with the bolts which are furnished with the pipe, no lead, yarn or caulking being necessary. The pipe is made in six foot lengths.

A special type of coupling is now manufactured which can be used on special cast iron pipe. It consists of two metal half-housings, an inner ring of special composition and two bolts. It is claimed that this type of coupling is "automatically leak-proof and can be installed faster at less cost than other type of coupling." Several railroads have installed this type of coupling, but it has not been in service sufficient time to make a definite statement as to its service in railroad work.

Lead and substitutes for joints in cast iron pipe, also cement, wood, and composition, were given special consideration by this Association in its report of 1925.

A compound selling under a trade name has been used quite extensively by several railroads. One of the claims made for this compound is that no caulking is required and that the labor cost is low. One of the objections to its use has been that it is necessary to burn out the joints and make them up new in case of leaks or repairs.

Several railroads have used a prepared lead joint cast iron pipe in small sizes. There are certain economies possible with the use of this type of joint, and, if properly laid and caulked, it will give satisfactory service.

Braided hemp, ordinary yarn, jute, and other material are used for packing bell and spigot pipe joints. One advantage offered in favor of the square braided hemp is that it automatically centers the spigot in the bell and eliminates the use of centering wedges. This may not be entirely so, particularly with large heavy pipe.

Placing

Small diameter cast iron pipe is easily handled without a derrick, the sections being lowered into the trench by a few men. Large pipe may be handled economically with a small derrick or crane. In placing bell and spigot pipe, care should be taken to enter pipe to its full length and to make sure that there is sufficient joint space all around. Cast iron pipe should be carefully bedded so as to have a uniform support under the bottom. The pipe should not rest on bowlders, rocks or similar unyielding objects. Probably more breaks of cast iron pipe lines have been caused by permitting pipe to rest on a rock or other unyielding objects than by any other cause. Likewise, large stones should not be permitted in the refilling close to the pipe. Blocking and wedges are placed under special castings and valves. Sharp curves are blocked against the side of the trench, or a mass of concrete is placed to take the reaction. The pipe should have been inspected for eccentricity, and the joint-room should not vary much from the required dimensions. The pipe should be clean inside when it is placed in the trench; open ends should be plugged when work is stopped to prevent stones or other objects getting inside.

Caulking

The pipe spigots should be adjusted to give a uniform joint space. The packing of jute or other material should be carefully inserted and thoroughly packed with a thin yarning-iron. If special strength is not required, this packing may nearly fill the space back of the enlargement in the bell. The remaining space is filled with molten lead, cement, or other substitutes. There may be economy in the use of a pneumatic caulker if there is much work to do.

Testing and Inspection

The pipe line as completed should be tested in sections of about 1000 feet or more under full working pressure by the application of internal pressure. For this purpose the ends are closed with specially made blanks which are provided with pipe fittings, valves, and gage attachments. The pressure used should be somewhat higher than that which will be obtained in regular service. It may be inconvenient to leave the entire pipe line uncovered until the test is made on account of trouble due to the temperature changes, but the field joints if possible should be left open for inspection. Wherever leaks are found the pipe should be recaulked. It is not always convenient to test the pipe line by hydraulic pressure in which case the test may be made by means of compressed air.

One western railroad tested a 5 mile, 12 inch cast iron pipe line with compressed air. A home made testing outfit was used, consisting of a 10 H.P. engine and air compressor mounted on a truck. The pipe line was tested in sections. The air compressor was connected to the main line by means of a 1½ inch pipe, connected to a cap over the end of the main. An air relief valve set at 125 pounds, a gage, globe valve, and check valve were placed in the line between the compressor and main. The joints were tested for leaks by brushing them with a solution of soft soap and water. Leaks were detected by means of the soap bubbles formed by the escaping air.

Pipe laying should be constantly and carefully inspected, and all pipe, specials, valves and other fittings should be examined before laying for incipient cracks and other defects.

Back-Filling

It is advisable to cover pipe lines to prevent the water from freezing or to protect them from extreme variations of temperature. A covering of two or three feet is usually sufficient to protect them from injury by ordinary traffic. The back-filling should be done carefully up to the top of the pipe, the material being placed and tamped. If the pipe is located under paved streets or tracks the back-filling should be thoroughly tamped. The back-filling should not contain cinders or other material that might cause early corrosion of the pipe. Neither should large stones be permitted in the re-filling close to the pipe.

Expansion and Contraction

In the case of cast iron pipe with lead joints sufficient expansion and contraction is usually provided due to the flexibility of the lead joints. One railroad reports the use of cement joints with a lead joint every fourth joint for flexibility and expansion. At a certain terminal, hot and cold water was pumped alternately through a pipe line with lead joints, causing leaks due to expansion and contraction at the joints. A remedy was provided by using clamps and straps to hold the joints tightly together. Special joints are made for pipe exposed to high internal pressure, or excessive expansion and contraction.

Stop Valves

Stop valves are placed in the pipe line at the time it is laid to enable it to be readily inspected and repaired. The interval at which these valves are placed may vary with the size of the pipe and the points where it can be emptied of water and refilled. A long line of pipe might require considerable time to fill. In the case of breakage the water can be shut off at the nearest valve and considerable waste or serious damage be prevented.

Air Valves

Automatic valves in pipe lines are installed at the summits and sometimes at shut-off valves to permit the escape of air on filling, and the entrance of air on emptying. There is a certain amount of air in water at all times, a portion of which is dissolved and another portion of which is mechanically entrained. This air in general, will collect at summits in the pipe line and

must be removed therefrom, otherwise there is a tendency to air binding which reduces the capacity of the pipe line. Air valves are usually connected to the main pipe by means of a short branch which is provided with a small valve to permit the removal of the air-valves for repairs. Air valves should be enclosed and protected from frost.

Blow-Off Valves

Blow-off valves should be provided at depressions at the time the pipe is placed. The valve usually is connected to waste pipe leading to sewers, streams, or drainage channels. The valves are usually smaller than the main pipe. The location of the valves should be clearly marked and the covers to the pits, in which the valves are placed, should be kept free from dirt, ice, snow, and other obstructions.

Check Valves

Check valves are placed at points where a break would permit a large loss of water by backward flow, such as at the foot of a long upward grade. They are also placed in force main just beyond the pumps as a protection against surge and excessive pressure that might damage the pump.

Pressure-Relief Devices

Safety valves, or pressure-relief valves, are usually installed at the ends of long pipe lines where water hammer may occur. The problem of satisfactory pressures may be complicated by topographical conditions. Pressure relief devices to give satisfactory service, should be of simple design containing few parts. Relief valves should not close so suddenly as to cause water ram in the pipe lines.

Protection at Bridge and Railroad Crossings

The amount of protection necessary to prevent freezing of water in pipe on bridges, or at other exposed places, depends upon the size of the pipe, the amount of circulation and temperature of air and the water, and upon the length of the exposed pipe. Small diameter pipe usually require more protection than large diameter pipe. A mixture of plaster of paris and sawdust has been used with good results for protecting water pipes. Usually the pipe to be protected is placed in a wooden conduit or box, and the filling around the pipe is some non-conducting substance, such as sawdust, mineral wool, asbestos, or other similar material. Expansion joints may be required in long pipe lines, on bridges or where the pipe is exposed for any considerable distance in order to take care of expansion and contraction due to variations in temperature.

Where cast iron pipe is laid under a highway or a track, or adjacent thereto, where vibration may cause damages, the pipe sections are sometimes strapped together at the joint with special clamps. Pipe of extra weight with special couplings may also be used as a precaution of future breakage.

Conclusions

1. Many of the service breaks are evidently results of minute fractures in pipe line, caused in the handling of same from the foundry to final

position in the trench. This matter should be carefully covered in all specifications as far as it is practicable.

2. The practice of supporting pipe in the trench on wooden supports should not be permitted. These supports rot and allow the pipe line to settle. If an individual pipe settles on a knuckle of a rock, it is very apt to develop a fracture.

3. Pipe laying should be constantly and intelligently inspected, and all pipes, valves, and special fittings should be carefully examined for small cracks and other defects before laying.

4. Cast iron pipe lines may be successfully laid with bell and spigot joints, caulked with jute and lead. Special joints, and substitutes for lead may be used. Each case should be carefully considered to determine which will be the best and the most economical method to use.

SPECIFICATIONS FOR LAYING CAST IRON PIPE

Material

All material shall be new and of the grade specified, and shall be the best of their respective kinds for the uses intended.

Specifications for cast iron pipe and special castings shall conform with the American Railway Engineering Association's standard specifications.

Specifications for hydrants and valves shall conform with the American Railway Engineering Association's standard specifications.

The lead shall be first class pig lead containing not less than 99.5 per cent pure lead.

Gaskets of hemp, jute or yarn shall be the best quality for the purpose and satisfactory to the Company's Engineer.

Alinement and Grade

The alinement and grade shall be established by the Company's Engineer and must be accurately adhered to by the Contractor.

Excavation

The bottom of the trench shall be even and true to the established alinement and grade and of sufficient width to permit proper laying of the pipe, making the joints, and tamping around and over the pipe.

Where necessary the trench shall be braced and shored to prevent caving and to protect the workmen. If the trench is left open after working hours, protection shall be provided, and after dark suitable lights shall be placed in conspicuous places as additional protection. If deemed necessary by the Company's Engineer, watchmen shall be provided on the work, day and night.

The length of trench to be opened or the area of the surface to be disturbed and restored at any one time shall be limited by the Company's Engineer.

New trenching will not be permitted when earlier trenches need backfilling, or labor is needed to restore their surfaces to a safe and proper condition.

The Contractor shall do all pumping, bailing, building of drains and all other work necessary to keep the trench clear and suitable for laying the pipe. All water, gas and other underground utilities encountered shall be protected and supported in such way as to prevent damage to them. When soft, yielding bottom is encountered in trenches, it shall be excavated and replaced with suitable material as directed by the Company's Engineer.

The Contractor shall carry on all trenching in such manner as not to disturb the tracks of the Company or interfere with the operations of the railroad and shall at all times so protect the trenches and excavations as to insure the safety of both railroad employees and the public.

Classification

Excavation will be classified as follows: "COMMON EXCAVATION," "ROCK EXCAVATION DRY," "WET EXCAVATION," "ROCK EXCAVATION WET," or such additional classifications as may be established before the awarding of contract.

(a) Common Excavation: Common excavation will embrace all dry excavation except rock, above low water.

(b) Rock Excavation Dry: Rock Excavation Dry will consist of rock, in place above low water in solid bed or in compact stratfied masses in their original position, which, in the opinion of the Engineer, will require blasting for its removal, and boulders or detached rock measuring one half (½) cubic yard or more.

(c) Wet Excavation: Wet Excavation will embrace all excavation, except rock, below low water.

(d) Rock Excavation Wet: Rock Excavation Wet will consist of rock in place, below low water in stratfied masses in their original position, which in the opinion of the Engineer, will require blasting for its removal and boulders or detached rock measuring one half (½) cubic yard or more.

Low water referred to in these specifications shall be the elevation at which water begins to run into the pit in such quantity as to require pumping or bailing and is to be agreed upon at the time the excavation is being made.

Measurement

Measurement of excavation shall be by the cubic yard, and in accordance with the proper classifications. Measurements shall be made in excavation only, except where otherwise specifically directed. Backfilling of the trench shall be included in the excavation measurements.

Measurement for pipe laying, including hauling, placing, caulking and testing, shall be by the linear foot. Payment for the placing of extra valves and special fittings shall be by the piece.

Pipe Laying

All pipe shall be laid in a workmanlike manner to the established line and grade and to rest uniformly throughout entire length. Pipes shall be shoved home and supported concentrically in the bell of the adjacent pipe. The pipe and fittings shall be thoroughly cleaned inside before being connected.

Bell holes shall be of sufficient depth and width to permit the making of satisfactory joints. The bell holes shall be kept dry until the joints are completed.

Valves, hydrants, special castings and fittings shall be set or laid as directed by the Company's Engineer.

All open ends shall be closed before stopping work.

Making Joints

(a) POURED LEAD JOINTS OF BELL AND SPIGOT PIPE.

The pipe spigot shall be so adjusted in the bell or hub as to give as nearly a uniform space all around as possible and if any pipe or fitting does not allow sufficient space for proper caulking it shall be rejected.

The caulking shall be done in such a manner as to secure a water-tight joint without overstraining the pipe.

Gaskets of hemp, jute or yarn shall be braided or twisted and tightly driven before running or pouring the joint. Before pouring the lead the joint shall be clean and dry. The joint shall be run full in one pouring and the melting pot shall always be kept close to the joint poured.

Lead joints shall not be at any point or place less than ¼ inch in thickness nor less than 2 inches deep.

No change of alignment of pipe shall be permitted after the joint is caulked.

(b) CEMENT JOINTS.

The. pipe shall be placed the same as for lead joints.

Gaskets of dry jute or hemp shall be used instead of oakum as no packing containing oils or grease will be allowed.

Dry cement shall be placed on a piece of clean canvass and moistened just enough so that when thoroughly mixed by hand it will be of such consistency that when gripped tightly by the hand it will hold its form and when dropped 12 inches it will crumble.

The canvas containing the cement shall be placed under the bell and the cement tamped into place by hand with a caulking iron until the bell is about half full. It shall then be caulked with heavy blows until the cement is thoroughly packed in the back of the socket.

This process shall be continued until the bell is packed solid out to the face.

A small bead of neat cement in a plastic condition shall then be put on, using the caulking iron as a trowel. As soon as the initial set of the cement in the bead has taken place, the joint shall be covered with earth to protect it from the air and sun. (In backfilling the excavated material when settled with water helps to set the exposed portion of the joint.)

Cement joints shall stand 48 hours before pressure is applied.

In making repairs, the old cement shall be entirely cut out, and replaced with fresh cement.

(c) COMPOUND—SUBSTITUTES FOR LEAD.

The pipe shall be placed the same as for lead joints.

(Specifications as distributed by manufacturers may be used as a guidance for Company's desiring to use these compounds.)

Prepared Joints

The jute and lead is placed inside the bell in the foundry. The spigot shall be entered completely into the socket and the lead caulked as specified for poured lead joints in paragraph 1a.

Special Pipe, Couplings and Fittings

(Specifications as distributed by manufacturers may be used as a guidance for Company's desiring to use special pipe, couplings and fittings.)

Testing

The entire pipe line including specials shall be tested by hydraulic pressure upon completion in the presence of the Company's Engineer. Tests shall also be made in sections of about 1000 feet as the work progresses (wherever possible between valves) and before backfilling the trench. The leakage shall not be more than .... gallons per day per inch diameter per mile. The test shall be made before the trench is entirely backfilled, and all joints found leaking must be recaulked and all cracked or broken pipes or fittings must be removed and replaced and the test repeated until the pipe line is satisfactory.

Back-Filling

The back-filling shall be done as soon after the pipe laying and testing as possible.

The back-fill from bottom of trench to top of pipe or fitting shall be first filled and well rammed or tamped. The material above the pipe may be loose filled and heaped to prevent depression, except at road crossings.

If for any reason the pipe or fitting is blocked up or if it does not securely rest on the bottom of the trench, the space under the pipe shall be carefully filled and well tamped.

At road crossings the back fill shall be placed in 6 to 8 inch layers and well tamped, and if necessary, puddled so that no depression will occur.

Earth placed close to the pipe shall be free of stones or boulders which might cause fracture of the pipe when struck with the tamp or rammer. Ex-

cess earth remaining after the trench has been filled shall be disposed of as specified for each particular installation. Only such excavated material designated acceptable for the purpose by the Company's Engineer shall be used for refilling the trench. Earth containing an appreciable proportion of cinders or ashes shall under no circumstances be replaced in the trench close to the pipe.

General Conditions

All materials entering into the work and methods used by the Contractor shall be subject to the approval of the Chief Engineer, and no part of the work shall be considered as finally accepted until all the work is completed and accepted.

Company, Engineer and Contractor Defined

As used in these specifications, the term Company shall be understood to mean the Railroad or Railway Company. The term Engineer shall be understood to mean the Chief Engineer of the Company, or his duly authorized representative, and the term Contractor shall be understood to mean the person, firm or corporation agreeing to perform the work covered by these specifications.

REPORT OF SPECIAL COMMITTEE ON MAINTENANCE OF WAY WORK EQUIPMENT

C. R. Knowles, *Chairman;*
G. R. Westcott, *Vice-Chairman;*
O. L. Beydler,
E. E. Christoph,
Walter Constance,
W. O. Cudworth,
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Philip Petri,
E. Pharand,
J. G. Sheldrick,
G. L. Sitton,
Harry Slabotsky,
F. M. Thomson,
J. B. Trenholm,
Fred Zavatkay,

Committee.

To the American Railway Engineering Association:

Your Committee presents herewith report on the following subjects:

(1) Definitions of Terms (Appendix A).

(2) Standardization of parts and accessories for railway maintenance motor cars (Appendix B).

(3) Methods of alarm for gasoline propelled track cars (Appendix C).

(5) Methods of scheduling and assigning of work equipment, giving particular attention to equipment used in seasonal work (Appendix D).

(6) Methods of keeping data on work equipment and labor-saving devices (Appendix E).

(9) Organization for the use and maintenance of tie tamping machines—air and electric (Appendix F).

(11) Care of work equipment when not in use, with particular reference to proper housing (Appendix G).

(12) Standard colors for work equipment and motor cars (Appendix H).

(14) Standardization of voltage, kind of current, etc., for use in electrically operated machines and tools for roadway purposes (Appendix I).

(15) Best practices of maintaining labor-saving devices on construction and maintenance of way work, and the organization of the necessary supervisory force (Appendix J).

Progress is reported on the following subjects:

(4) Types of snow-melting devices.

(7) The selection and training of maintainers and operators of work equipment.

(10) Organization for the use and maintenance of ballast cleaning machines.

Subjects 8 and 13 have been transferred to another committee.

Bulletin 333, January, 1931.

Action Recommended

(1) That the report be adopted for publication in the Manual as recommended practice, and the subject continued.

(2) That the report be received as information and the plans be adopted for publication in the Manual as recommended practice, and the subject continued.

(3) That the report be received as information, and the subject discontinued.

(5) That the report be received as information, and the subject continued.

(6) That the report be received as information, and the subject continued.

(9) That the report be received as information, and the subject continued.

(11) That the report be received as information, and the subject discontinued.

(12) That the report be adopted for publication in the Manual as recommended practice, and the subject discontinued.

(14) That the report be received as information, and the subject discontinued.

(15) That the report be received as information, and the subject discontinued.

Respectfully submitted,

SPECIAL COMMITTEE ON MAINTENANCE OF WAY WORK EQUIPMENT,

C. R. KNOWLES, *Chairman.*

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Appendix A

(1) DEFINITIONS OF TERMS USED IN CONNECTION WITH MAINTENANCE OF WAY WORK EQUIPMENT

C. R. Knowles, Chairman, Sub-Committee; Walter Constance, William Elmer, Robert Faries, P. R. Henderson, F. S. Hewes, L. B. Holt, Jack Largent, J. B. Mabile, C. H. Ordas, G. R. Westcott.

Adzing Machine.—Portable power-operated machine designed to adze the rail seat on ties to provide proper bearing for rail or tie plates.

After-Cooler.—A cooling device for reducing the heat of compression in the final stage of compression and for the extraction of moisture.

Air Compressor.—A machine for compressing air from one pressure, usually atmospheric pressure, to a higher pressure for use as a motive force in mechanical operations.

Air Compressor, Multiple Stage.—A compressor with two or more compressing cylinders, the air passing from one cylinder to another, the pressure being increased in each successive cylinder and discharged into the receiver or transmission line at the ultimate pressure desired.

Air Compressor, Single Stage.—An air compressor with one or more compressing cylinders from which the air is discharged direct into the air receiver or the transmission line.

Air Compressor, Single Acting.—One in which the air is compressed on but one stroke of the piston.

Air Compressor, Double Acting.—One in which the air is compressed on both strokes of the piston.

Air Receiver.—A closed receptacle into which the compressed air is discharged by the compressor.

Air Hose.—Laminated rubber and canvas tubing for conveying air under pressure. It is used in operating air tampers and other pneumatic tools and for spray-painting, cement-gun work, etc.

Ampere Hour.—The common unit for measuring current consumption, being the amount of electricity transferred by a current of one ampere in one hour.

Ampere-Hour Capacity.—The number of ampere-hours which can be delivered by a cell or battery under specified conditions as to temperature, rate of discharge and final voltage.

Armature.—The rotating part of a motor or dynamo or magneto. It consists of a laminated iron cylinder or core keyed to a shaft, and in the slots of which are wound the armature coils of insulated copped wire or ribbon. At one end of the core on the shaft is mounted the commutator, a copper cylinder composed of insulated segments, which are connected to corresponding armature coils.

Armored Hose.—Hose covered with a woven wire fabric, steel or other material, to protect it from injury or abrasion.

Axle.—A shaft on or with which a wheel revolves.

Ballast Car.—A car specially used for transporting ballast and designed to facilitate unloading into the track space and as nearly as possible in the correct amount. It is also frequently convertible for use in revenue service.

Ballast Cleaner.—Any device by which the dirt or other foreign matter is removed from broken stone, hard slag or washed gravel ballast.

Ballast Crusher.—A machine designed to crush or recrush stone and boulders to sizes suitable for ballasting tracks. The usual types are the gyratory, jaw and disc crushers.

BALLAST DISCER.—A device consisting of a set of discs attached on either or both sides of a motor car, and placed so as to run at an angle with the track, each set containing one or more discs designed to remove plant growth, promote drainage and improve the contour of the ballast section.

BALLAST PLOW.—A device for plowing stone from between rails, or designed to be pulled over flat or convertible cars to unload ballast by scraping and pushing it from the sides and distributing it along the tracks. It may be made center, right or left hand.

BALLAST TAMPER.—A portable machine actuated by compressed air or electricity, or other mechanical device for compacting ballast under the ties of railway track.

BALLAST TAMPING.—The compacting of particles of ballast under the ties for the purpose of maintaining the surface of the track.

BALLAST UNLOADER.—A friction drum machine operating device, consisting essentially of an engine, usually connected horizontally and in tandem to a grooved steel drum, around which may be wound a cable, used to pull a ballast plow over cars loaded with ballast or filling material.

BATTERY.—A group of cells electrically connected. (A.I.E.E.)

BEARING, ANTI-FRICTION.—The points of support of a revolving axle, shaft or other part moving in contact with another, so designed as to reduce friction. Anti-friction bearings are usually: (a) ball bearings, which may take either radial or thrust pressure or both, (b) roller bearings, which may take either radial pressure only, or both radial and thrust pressure.

BEARING, AXLE.—The bearing in which the axle of a motor car or trailer or other unit of roadway machinery turns. If of anti-friction type it includes inner race, balls or rollers, outer race, housing and pedestal, the housing and pedestal being commonly in one piece.

BEARING, PLAIN.—The points of support of a revolving shaft or other surface moving in contact with another as the face of a thrust collar.

BOOM (Crane, Shovel or Derrick).—The heavy swinging arm which carries the crowding engine and ratchet beam of a steam shovel and forms the power arm of a railroad ditcher, locomotive crane, etc. It is stepped at the foot of the "a" frame of the steam shovel or derrick and the mast of the other types of equipment, being held in its inclined position by the boom guys.

BOX, BATTERY.—A shallow receptacle for housing batteries. (Signal Section A.R.A.)

BOX, STUFFING.—A device used to prevent the escape of liquids or gases around a rod or stem.

BRAKE.—The whole combination of parts by which the motion of a car or machine is arrested or retarded. It almost always works through friction and may be mechanical (band or shoe brake), electrical (magnetic brake), or pneumatic (air brake).

BRAKE SHOE.—A block of wood or metal formed to fit the tread of a car wheel.

BUCKET, AUTOMATIC.—A bucket usually made in two or more parts and provided with mechanical means of opening and closing. It may be single-line or two-line. It is used for handling various materials such as earth or coal, and may be of the clam shell, orange-peel or drag line type.

BUSHING (Bearing).—A metal cylinder which is inserted in an opening and forms a bearing as on a shaft.

BUSHING (Pipe Fitting).—A short tube threaded inside and outside, used to screw into a pipe fitting to reduce its size.

CAM.—A device used to convert rotary into reciprocating motion; commonly an eccentric disc.

CAMP CAR.—A car used as portable living quarters for workmen employed along a line of railway.

CANVAS.—A coarse cloth, made of cotton, used for curtains on work equipment and for covering motor cars and other equipment to protect it from the weather.

CAR, TRACK.—Any car or machine operated on track, such as motor car, hand car, trailer, or other device not on M.C.B. trucks.

CAR, HAND.—A light four-wheeled, hand-operated railway work car supplied to maintenance employees for transporting men and tools.

CAR, MOTOR.—A small car propelled by a gasoline engine and for transporting workmen and their tools and materials over railway tracks.

CAR, OUTFIT.—Any car used by transient gangs as living quarters or for handling tools and materials, includes camp cars, tool cars, material cars, water cars, etc.

CAR, SECTION.—A motor car designed primarily for the use of a section gang in track maintenance. Cars of this type vary widely in design, weight and horsepower of engine and commonly include nearly all designs of track motor cars.

CAR, LIGHT SECTION.—A motor car weighing from 750 to 900 lbs. with a seating capacity of 4 to 6 and capable of being handled on or off the track by two men. Cars of this type are usually propelled by 4 to 6 H.P. engines. It is commonly used by small section and similar maintenance of way gangs.

CAR, STANDARD SECTION.—A motor car weighing from 900 to 1200 lbs. with a seating capacity of from 6 to 8 men and a total load capacity of 2500 lbs. Cars of this type are usually propelled by 6 to 8 H.P. engines. It is largely used on standard main line sections.

CAR, HEAVY SECTION.—A motor car weighing from 1200 to 1400 lbs. with a seating capacity for 10 to 12 men, is equipped with 8 to 12 H.P. engines. Used largely with large section or extra gangs and will haul one or more trailers with men and tools.

CAR, HEAVY DUTY.—A motor car weighing from 1400 to 2000 lbs., or more, and designed for hauling trailers and such other equipment as ballast discers and weed mowers; it is also used for hump yard service. Seats and decks are sometimes lengthened to accommodate a large number of men. It is propelled by engines ranging from 12 to 30 H.P.

CAR INSPECTION.—A motor car used for inspecting track and right-of-way. Inspection cars are of two classes, light inspection cars carrying up to four persons, and the party inspection car accommodating as many as 12 persons.

CAR, PARTY INSPECTION.—Any car with a capacity of four or more men used exclusively for inspection purposes. Motor cars of this type cover a large range of sizes and kinds.

CAR, LIGHT INSPECTION.—A motor car designed to carry one or two men and tools. They vary in weight from about 400 to 600 lbs., the lighter car being designed for use by one man. They usually have a load capacity of 650 to 800 lbs.

CAR, PUSH.—A four-wheeled railway work car, designed to be pushed by hand, but not uncommonly used as a trailer with a motor car, and supplied to maintenance employees for transporting materials too heavy to be carried on a hand or motor car.

CAR, TRAILER.—A four-wheeled railway work car, somewhat similar to a push car, to which it is convertible, but of a more substantial construction so as to permit its movement at speed while attached to a motor car. It is sometimes provided with a removable seat top for carrying men and is usually equipped with roller bearings.

CARRIAGE BOLT.—A bolt made square under the head so as to prevent it from turning when in its place. They have thin button-shaped heads and are used in wood.

CARBURETOR.—A device by which the gasoline used in the cylinder of an internal combustion engine is vaporized and mixed with air for proper combustion.

CASTELLATED NUT.—A nut having slots cut crosswise in the upper portion. The nut is screwed on a bolt so that one of the slots coincides with a hole through the bolt to permit of inserting key, thus securing the nut.

CELL.—A single element with electrolyte and container. (A.I.E.E.)

CELL, DRY.—A primary cell using zinc as the positive electrode, carbon as the negative electrode and ammonium chloride for the electrolyte. (Signal Section, A.R.A.)

CHAIN DRIVE.—A means of transmitting power employing the use of sprockets and chain in place of pulleys and belt.

CLAM-SHELL.—A grab bucket having a tray composed of two equal opposite scoops, which spread to open on the material to be lifted, and sink into the material through the weight of the bucket when closing. It is in common use as an accessory to a crane or derrick for handling bulk materials and is also used for earth excavation.

CONVERTIBLE CAR.—A car so built that it may be converted without reconstruction from one type to another, as center dump gondola to side dump gondola. In the former type it is effective as a ballast car, in the latter as a car for grading.

COUPLER.—The device by means of which any car or machine to be towed is connected to the towing agency. Coupler includes draw head, and coupler link and pins, or other device for connecting two draw heads.

CRANE.—A weight-moving machine designed for direct lifting and also for horizontal movements which may be circular, radial or universal. It is of many different types, as stationary, locomotive, traveling, gantry, etc.

CRANE, CRAWLER.—A revolving self-propelling machine having functions similar to those of the locomotive crane, but equipped with crawler treads in place of wheels, so as to travel on the ground or over the floor of cars.

CRANE, LOCOMOTIVE.—A revolving boom self-propelling, long-boomed, general utility crane, gasoline or steam operated design to handle a grab bucket, lifting hooks or magnet, to move coal for locomotive use, to handle track materials, cinders or scrap metals, to erect bridges, excavate foundations, etc.

CYCLE (Electrical).—One complete set of positive and negative values of an alternating current. (A.I.E.E.)

CYCLE (Engine).—A period in the operation of an internal combustion engine, as two cycle or four cycle.

DECK, SEAT.—The portion of the deck of a motor car or trailer that is raised above the remainder of the deck to serve as seat for the occupants of the car. On a motor car the engine and gasoline tank are commonly located under the seat deck.

DERRICK CAR.—A crane which is used for removing wrecked cars and engines, erecting bridges or handling any heavy objects. Also called a wrecking crane.

DERRICK, CRANE.—A crane with a mast held upright by fixed stays, extending from its top to the rear, which limit the radial movements of the boom.

DIESEL ENGINE.—An internal combustion engine in which fuel oil, blown as a vapor into the cylinder, ignites spontaneously from heated air previously compressed by the engine to a pre-determined point above the firing point of the fuel.

DIRECT DRIVE ENGINE.—A term applied to a motor car engine that is direct connected to the drive axle of the car, thus making it necessary to push the car to start the engine.

DITCHER.—A revolving type of self-propelled gasoline or steam shovel pivoted on a geared turntable mounted on a frame usually carried on a standard car body and trucks, or sometimes on four small double flanged wheels

made to run on lapped sections of track laid loosely on flat car floors. It is primarily designed to excavate side ditches in railway cuts, and to cast the material to the top of the excavation or load it into cars at either end or side of the one upon which it is carried.

DITCHER (Jordan Type).—A heavy car having mounted on each side a steel plow shaped to cut roadway shoulder and ditch to proper contour. Excavated material is pushed to the top of the cut or moved ahead of the plow to lower ground at the end of the cut.

DOLLY, TRACK.—A car operating on one rail only designed to be pushed by hand. It may be equipped with box for handling ballast or earth.

DRAG LINE BUCKET.—A rectangular bucket having one end open to admit the earth or other material, which, as the bucket is dragged over it, is loosened by means of a number of sharp, beveled steel teeth fastened to the mouth of the bucket.

COUPLER DRAWBAR.—The portion of a coupler used to connect the draw heads of two cars or other units of roadway machinery.

COUPLER DRAWHEAD.—That portion of a coupler that is rigidly attached to motor car, trailer or unit of roadway machinery designed to be towed.

DRILL, BONDING.—A drill similar to a track drill but designed only for drilling small holes through web of rails for attaching bond wires.

DRILL.—Any tool or machine used for boring holes in metal, stone or other substance; specifically a steel cutting tool, sometimes a straight steel bar driven with a sledge, but usually a bit fixed to a drill stock or a drilling machine. The principal uses of drills include well drilling, making holes for blasting rock, and boring through metal, notably in the fabrication of steel structures such as bridges, in the making of frogs, switches and crossings out of track rails, and in the drilling of rails in track for joint bars and for rail bonds.

DRILL, FLAT.—A boring tool made from a flat piece of tool steel with double beveled cutting point used chiefly for drilling holes through the web of rail for track bolts.

DRILL, PNEUMATIC.—Any compressed air driven tool used for drilling, reaming and boring in metal or other hard substances.

DRILL PRESS.—A bench tool for drilling holes, consisting of a movable work table and an iron frame in which a vertical revolving spindle is mounted to carry the drill-bit.

DRILL, ROCK.—Any device designed for making holes in rock. The term is commonly limited to the portable machine tools operated by steam, compressed air or electric power to prepare holes for blasting excavations in rock, such as for railway excavations, tunnels, etc.

DRILL, ROTARY HAND.—A holding device for a drill-bit; specifically a hand-operated drilling machine which, when equipped with a drill-bit and pressed by hand or breast against the work, bores or drills holes.

DRILL, TRACK.—A machine tool designed to operate horizontally to drill holes through the webs of track rails, especially for track bolts. It may be a one-man ratchet drill or a geared drill machine with a frame, rail clamps, feed screw, high speed steel bit and chuck and alternating crank handles turned by two men or power operated.

DRILL, TWIST.—A steel boring tool similar to a wood boring bit, the spiralled portion usually 3 in. or more in length and ending in a wide-lipped, double-beveled point, while the shank is shaped to fit in a brace or chuck for operation by hand or by power.

DROP HAMMER.—A type of pile driver hammer which is raised by means of a hoisting engine and permitted to drop by gravity on the head of the pile.

DUMP CAR.—A car designed to discharge its load with a minimum of time and labor. Automatic dump cars discharge the load by tilting the body, which is usually accomplished by means of compressed air. Hopper bottom dump cars discharge the load by gravity through manually operated trap doors and may be either center dump where load is discharged

between the rails or side dump where the load is discharged outside the rails. Convertible dump cars may be changed from center dump to side dump without reconstruction. Dump cars from which the entire load is discharged freely are self cleaning cars.

ENGINE, FOUR-CYCLE.—An internal combustion engine receiving a power impulse in each cylinder at each second revolution.

ENGINE, GAS.—An internal combustion engine using natural or manufactured gas as fuel. (A.R.E.A.)

ENGINE, GASOLINE.—An internal combustion engine using gasoline, naphtha or other volatile petroleum products as fuel. (A.R.E.A.)

ENGINE, INTERNAL COMBUSTION.—A prime mover in which the power is derived from the expanding gases during combustion of the fuel compressed and ignited in a cylinder and acting directly against the piston.

ENGINE, OIL.—An internal combustion engine which is started and operated on a non-volatile oil of medium low Baume degrees, the fuel being ignited from a surface heated by previous combustion of the fuel. (A.R.E.A.)

ENGINE, TWO-CYCLE.—An internal combustion engine receiving a power impulse in each cylinder at each revolution. (A.R.E.A.)

EXCAVATOR, DRAG LINE.—A revolving, long-boomed power-operated crane designed to handle a drag line bucket at the end of a wire cable. This machine is frequently used in excavation too wet to support a steam shovel and not accessible to horse drawn scrapers.

EXTENSION HANDLES.—Lifting handles applied to track motor cars or other light work equipment so designed that they pull out from the body of the car or equipment. Facilitates the removal of equipment from track by increasing the leverage obtained.

FLANGE.—A projecting drag, rib or rim on any object as the base of a rail or the top and bottom horizontal parts of a beam or girder, designed to furnish the necessary resistance in tension or compression in flexure.

FLANGE (Wheel).—A projecting collar on the inside edge of a car wheel by means of which it is kept on the rail.

FLANGER.—A form of plow, sometimes placed under a special car called a flanger car, or under a snow plow, for clearing ice and snow from the inside of the rails to provide a clear passage for the wheel flanges. Flangers are also frequently attached to locomotives, either on or just behind the pilot.

FLASH POINT.—The temperature at which escaping vapor will ignite momentarily, usually applied to oils and hydro-carbons.

FLYWHEEL.—A heavy wheel placed upon the crankshaft for the purpose of equalizing the power of an engine.

FREE RUNNING ENGINE.—A term applied to a motor car engine connected to the drive axle of the motor car in such a manner that the engine may be started and run without moving the car, the power being transmitted to the axle by means of a clutch, friction disc or belt.

FREE AIR.—Air at atmospheric temperature and pressure.

GAGE OF TRACK.—The distance between the heads of the rails, measured at right angles thereto at a point ⅝ inch below the top of the rail. The standard gage is 4 feet 8½ inches. (A.R.E.A.)

GASKET.—A thin sheet of rubber, cloth, paper, sheet metal or other material forming a joint between two pieces of metal to prevent leakage.

GEARING.—A train of cog wheels, the teeth of which are in mesh.

GEAR.—A cog wheel, the rim of which is fitted with cogs or teeth for the purpose of engaging another gear or pinion.

GOVERNOR, AIR.—A device used on an air compressor for determining the range in air pressure over which the compressor operates. (Signal Section, A.R.A.)

GRINDER, TOOL.—A portable tool-sharpening device, with revolving wheel or cone mounted on a spindle, rotated by means of gears, and operated by hand, foot or other power. It is usually provided with attachments for holding the tools in proper position while being ground.

GROUND WIRE.—A wire used in making a connection between a ground and grounded parts.

GROUNDED PARTS.—Electrical devices which may be considered as having the same potential as the earth. (A.I.E.E.)

HAMMER (Pile).—A weight used to drive piles. (A.R.E.A.) Such appliances fall into the general classes of "drop" and "steam" hammers, and operate between the uprights of pile drivers.

HAMMER, PNEUMATIC.—A bearing or striking tool driven by compressed air, used for driving rivets.

HOISTING DRUM.—The barrel about which is wound the chain rope or cable attached to blocks and other hoisting apparatus.

HOISTING ENGINE.—The engine geared to the hoisting drum of a crane, derrick or other lifting machine.

HOSE.—Flexible tubing made of woven fabric, rubber or metal for conveying air, steam, water, or other fluids. Hose clamps are used to bind the hose to the hose nipple and coupling.

HOSE CLAMP.—A clamp for fastening the hose to the hose nipple or coupling.

ICE CUTTER.—A flanger car equipped between the trucks and beneath the floor with a toothed steel beam, set on edge diagonally across the track between the rails and raised or lowered by means of compressed air, of running rails to loosen hard snow and ice between and just outside.

INTER-COOLER.—A cooling device for extracting the heat of compression between the compressing cylinders of a multiple stage compressor.

JOURNAL.—The part of an axle or shaft on which the journal bearing rests.

KNIFE SWITCH.—A switch having a movable blade of copper or brass which makes a contact between two parallel contact springs, commonly used on power switchboards of signal systems.

LEADS, PILE DRIVER.—The upright parallel members which support the sheaves used to hoist the hammer and piles, and which guide the hammer in its movement. (A.R.E.A.)

LOCK NUT.—The outer one of a pair of nuts on one bolt, which, by screwing up separately to a tight bearing locks the inner one.

LUBRICATION.—The application to moving surfaces in contact, such as parts of machines, of a substance to prevent friction. The more common lubricants are the light and heavy grades of oil, the greases and the solid lubricants, such as the soapstones, graphites, etc.

LUBRICATOR.—A device for applying oil to a journal or other moving part. Also called oiler.

MIXER, BATCH.—A machine for mixing concrete in separate batches as distinguished from concrete mixed by a continuous mixer. (A.R.E.A.)

MIXER, CONTINUOUS.—A machine designed to maintain a continuous process of concrete mixing. Continuous mixers are now little used.

NUTLOCK.—A device for locking the nut in place on the bolt after it has been drawn up.

ORANGE PEEL BUCKET.—A grab bucket with a tray composed of three or four equal sharp-pointed scoops which, when closed, meet in a point at the base, their outward convex triangular plates constituting a round bottomed bowl like the peel of half an orange cut vertically in equal parts.

PACKING.—Any material used in a gland to make a tight joint around a valve stem, piston rod or other similar part. Leather, rubber or metal rings are used. Also the oiled waste for lubricating bearings.

PAINT SPRAYING MACHINE.—A device for applying paint by means of compressed air consisting of power unit, air compressor, paint containers, hose and spray gun.

PILE DRIVER.—A machine for driving piles. It may be supported on a railway car for use on track or on a scow or barge for use in the water.

PINION.—A small cog wheel engaging a larger one.

POWER TOOLS.—Those operated by a specific type of energy as gasoline engine, electricity or compressed air, including such machines as drills, grinders, hack saw machines, etc.

PULLEY.—A wheel with a grooved, flat or slightly convex rim, adapted to receive a cord or belt which runs over it. It is used to transmit power or change the direction of motion. A pulley wheel in a block is a sheave, but the two words are used interchangeably.

RAIL SAW.—A power machine, provided with a circular saw of either the toothed or friction type, used to cut steel rails. Small portable machines are in common use and larger units mounted on a railroad car are also employed.

RAIL SKIDS.—Two metal rails securely fastened to the underside of motor car frame to act as skids in placing car on or off the track.

RHEOSTAT.—A resistance used in connection with the controller for limiting the current taken by the motors, during acceleration. Usually consists of a number of iron grids or strips of iron ribbon properly connected and packed in a substantial frame.

ROTARY SNOW PLOW.—A car having at the front end a bladed wheel, set at right angles with the track and driven by an engine on the car, which, as the car is pushed forward by a locomotive, cuts the snow from before the plow and discharges it to one side of the track.

SAFETY RAILS.—A railing usually made of iron pipe applied to a motor car or trailer to serve as hand hold for occupants of car as a means of safety.

SAWS (Portable Rail).—Hand or power-operated portable machine designed for sawing rails in or out of track.

SCRAPER DUMP.—A scoop, usually of steel, used to move loose earth, etc., as in railway grading or foundation excavation. It is commonly hauled by horses, though in some cases by cable from a power source. Scrapers are of the drag, wheeled and fresno, or buck, patterns.

SELF-CLEANING CAR.—A car having a floor forming one or more hoppers, with doors at the bottom which, when opened, permit the load to discharge by gravity. Hopper cars, ballast cars, side dump cars, etc., are generally self-cleaning.

SIDE DUMP CAR.—A car so constructed that its contents may be discharged to either side or to both sides of the track, through doors in the car sides, by means of an inclined floor and side doors, or by tipping the car body sidewise.

SNOW CRAB.—A car equipped at its rear end with high, vertically-hinged side wings adaptable to being spread to cut into deep snow on each side of the track with the vertical cutting edges of their divergent braced surfaces, in order to draw the snow in between the rails behind the car whence it may be handled with a following rotary plow, thus widening the snow cut.

SNOW MELTER.—A contrivance designed to thaw and to prevent the accumulation of snow and ice in the tracks; sometimes a torch designed to be held close to the snow or a steam, electrical, oil or gas heating device designed to be placed adjacent to or attached to the rails through the switch leads, at interlockers or railroad crossings, etc.; and sometimes a chemical to be poured or strewn along the tracks.

SNOW MELTING OIL.—Any volatile oil, rich in hydrocarbon, the flame from which may be used for melting snow as it falls, especially at interlocking plants. It is used in hand vessels with a narrow spout wrapped with asbestos to form a sort of torch and in stationary pots.

SNOW PLOW.—A machine for removing snow from railway tracks. It may be a complete unit such as a push plow on its own trucks or a rotary plow with its steam plant for operating the snow wheel; or an attachment for standard equipment, such as pilot plow, a snow crab or a flanger.

SNOW SWEEPER.—A car equipped with brushes, near the rails, and the necessary machinery to revolve them; used for sweeping snow from the rails.

SPARK COIL.—A coil of insulated wire connected with the ignition system of a motor car for the purpose of increasing the intensity of the spark produced by battery.

SPARK GAP.—The air space or gap through which a disruptive electric discharge passes. A gap forming part of a circuit between two opposing conductors and filled with air or other dielectric, across which a spark passes when a certain difference of potential has been reached.

SPARK PLUG.—A device for igniting the charge in an internal combustion engine by means of an electric current.

SPLIT KEY.—A form of pin which is self-fastening, consisting essentially of two parallel strips or bars of metal, which, when united, constitute one pin, but the ends of which may be forced apart to prevent the pin being withdrawn.

SPREADER.—A car fitted with movable side wings, to form a push plow at the forward end, operating diagonally to the center line of the track for the purpose of leveling distributed ballast or other material down to the top of the rail or lower and spreading it over the surface of the roadbed. It is also used for widening embankments and excavations, and is sometimes equipped with extension wings for widening roadbeds, deepening side ditches in cuts, clearing snow from track, etc.

STEAM HAMMER.—A hammer which is operated automatically by the action of a steam cylinder and piston supported in a frame which rests on the pile.

STEAM SHOVEL.—A shovel operated by steam hoisting engines mounted on a car. The shovel or dipper may hold from ½ to 6 cu. yd. of material and is mounted on the end of a heavy beam, which is carried by a swiveling boom. The dipper is operated and controlled by engines in such a manner as to permit of its being filled with earth or other material lifted and swung over an adjacent car or dump pile and there dumped. It is used in construction, ballast loading, coal handling, etc.

SWEEP, RAIL.—Two flexible parts attached to the front of a track car in such a location as to brush from the rail, as the car moves forward, any easily removable obstruction on the top of the rail.

TACKLE BLOCK.—A mechanical contrivance consisting of one or more grooved wooden or metal pulleys mounted on an axle held in a casing which is also provided with a hook, an eye or a clevis by which it may be attached. Used to transmit power or to change the direction of motion.

TAMPER, AIR.—An air driven tool used for compacting ballast under ties. Commonly used in sets of four, eight, or twelve tools in connection with portable air compressor of appropriate size.

TAMPER, ELECTRIC.—An electrically driven tool used for compacting ballast under ties. Commonly used in sets of four, eight, or twelve tools in connection with portable generator set of appropriate size. (Electric Tampers are of three general classes, vibratory, magnetic impulse, and mechanical impulse).

TAMPER, MECHANICAL.—A power driven machine for compacting ballast under ties.

THREADS, CUT.—Screw threads on a bolt or rod, formed by cutting away a portion of the material. The maximum diameter of the threaded portion of a bolt with cut threads is the same as the diameter of the bolt.

THREADS, ROLLED.—Screw threads on a bolt or rod, formed by displacing but not removing a portion of the material. The maximum diameter of the threaded portion of a bolt having rolled threads is greater than the diameter of the bolt proper.

TOOL TRAY.—The portion of the deck of a motor car that is used for loading of tools and so designed as to prevent tools from falling off the car.

THRUST COLLAR.—A collar fastened to a shaft or axle by means of a set screw to prevent its shifting endwise.

THUMB SCREW.—A screw with two projecting flat sided flanges adapted to be turned with the finger and thumb.

TIE SCORING MACHINE.—A portable power-operated machine provided with two circular saws designed to saw the face of track ties to uniform width and depth as a guide for hand adze work to provide a proper bearing for rail or tie plates in relay track work.

TRACK CRANE (Also called Maintenance Crane).—A power operated locomotive crane of small capacity used principally for setting rails in the track in renewals, but having many similar applications in maintenance work.

TRACK LAYING MACHINE.—A machine designed to minimize the manual labor of placing rails, fastenings, ties, and other materials.

TRACK OILING MACHINE.—Power-operated machine usually mounted on some type of self-propelled car designed for the purpose of applying oil on rails below the ball and/or track fastenings. Oil applied to resist rust and corrosion and prevent freezing of joints.

TWO-SPEED TRANSMISSION (Motor Car).—A device applied to any motor car drive to change from a faster to a slower movement with an increase of power, which is usually effected through the medium of a jack shaft, power being transmitted to the latter by belt and thence to the drive axle by roller chain and sprockets. It is designed for the purpose of extending the scope of the motor car to include that of both the section and the extra gang car, also to enable it to start heavy loads and operate on heavy grades.

VELOCIPEDE CAR.—Commonly termed a "Speeder." A light three-wheeled railway inspection car designed to be propelled by one or two men and used principally by lamp tenders, telegraph linemen, watchmen and others to travel short distances.

VOLT.—The unit of electric pressure or electro-motive force.

VOLTMETER.—An instrument for measuring the voltage of electric current.

WEED BURNER.—A machine for burning weeds from the track and roadbed shoulder. A flame type burner consists of a fuel tank, a blower which furnishes the blast for the burner, and the burner itself, usually of the atomizing type using either distillate or kerosene, and a hood designed to protect the flame from the wind and deflect it to the roadbed. Superheated steam, drawn from a locomotive and applied close to the ground by means of perforated pipes, also performs a duty similar to that of a weed burner.

WEED DESTROYER.—A device for cutting or mowing, or a gas or liquid for burning or poisoning, weeds growing on the roadway. Discing and mowing machines are available as separate units or may be attached to the motor car, while the burning and poisoning are usually done by special equipment moving as a train over the road.

Appendix B

(2) STANDARDIZATION OF PARTS AND ACCESSORIES FOR RAILWAY MAINTENANCE MOTOR CARS

G. R. Wescott, Chairman, Sub-Committee; O. L. Beydler, Walter Constance, W. N. Eddens, Jack Largent, E. H. Ness, C. H. Ordas, Harry Slabotsky, J. B. Trenholm, Fred Zavatkay.

Until this year, this subject, which has been under consideration since 1926, was handled by Committee XXII—Economics of Railway Labor. Upon the formation of the Special Committee on Maintenance of Way Work Equipment this year, the subject was transferred to the latter Committee, as the matters involved were more closely identified with the work of the Special Committee than with the work of Committee XXII—Economics of Railway Labor.

Up to the present time, the studies and conclusions cover only parts of that type of motor cars commonly used in section duty. During 1929, especial attention was given to details of wheels and axles, and the work this year was concentrated on couplers, safety rails and tool trays.

In its work this year, your Committee has studied the practice of considerable number of railroads and has also had the counsel and advise of motor car manufacturers, who have shown a fine spirit of co-operation in developing practices that would be acceptable to both railroads and manufacturers.

The following is offered as recommended practice (see following pages).

Progress is also reported on standardization of other motor car parts and accessories, such as size and type of bolts, types of gasoline lines, flagging equipment box, rail sweeps, wind shields, rail skids, etc., now under consideration.

Conclusion

That the plans be adopted as recommended practice and be printed in the Manual.

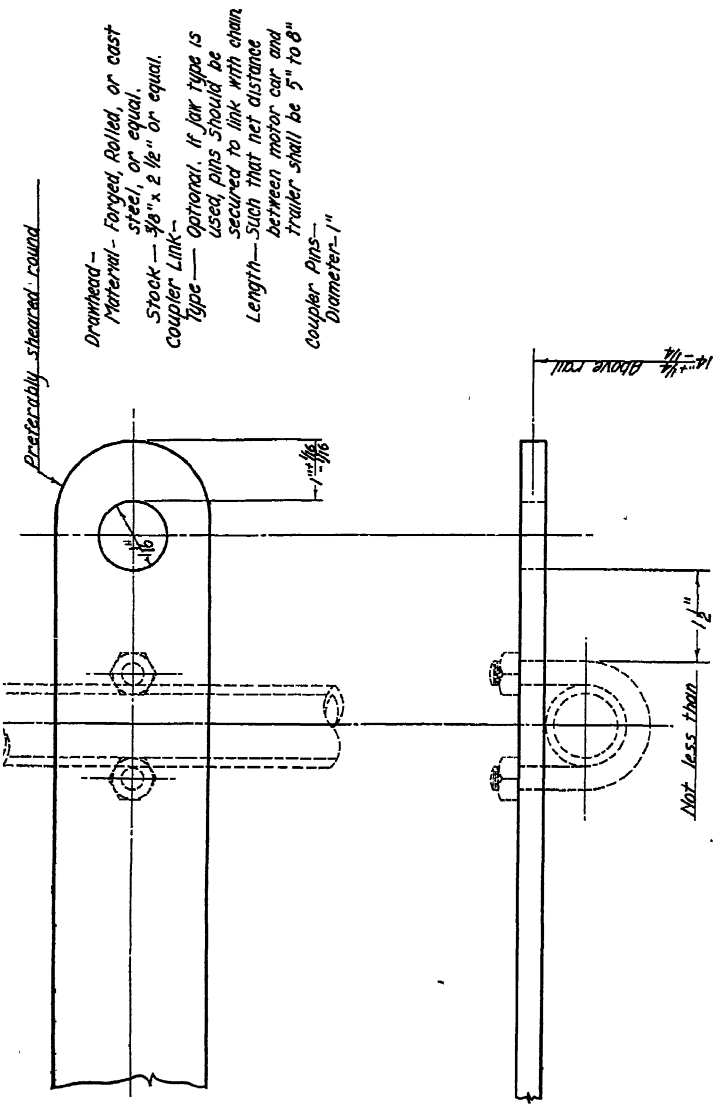
Appendix C

(3) METHODS OF ALARM FOR GASOLINE PROPELLED TRACK CARS

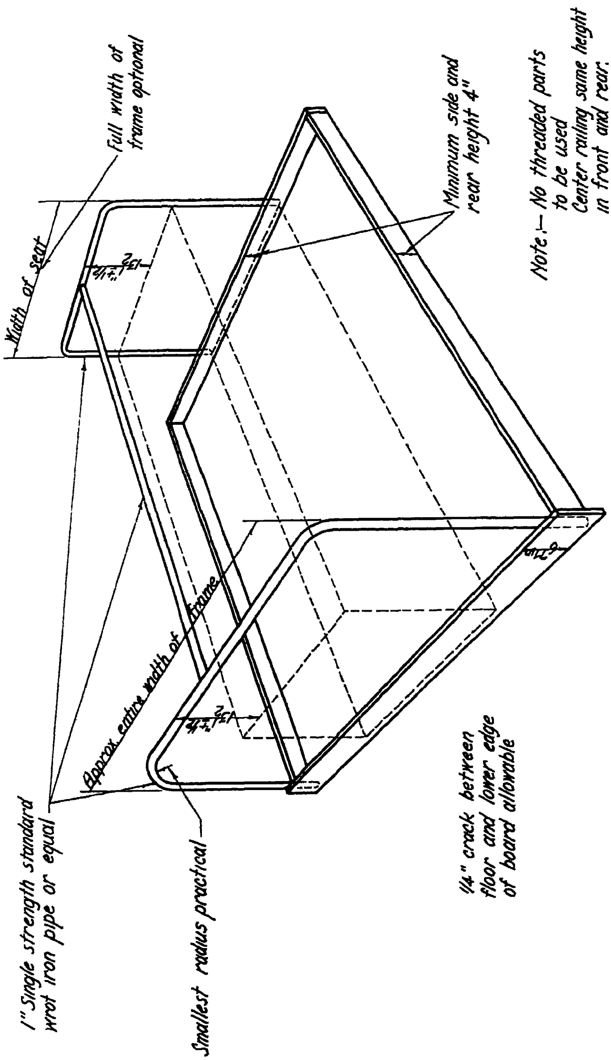
C. H. Ordas, Chairman, Sub-Committee; E. E. Christoph, J. F. Donovan, W. R. Gillam, C. H. R. Howe, H. B. Hoyt, J. B. Mabile, Philip Petri.

There does not seem to be any established rule or practice as to warning devices used on railway track cars. The various devices in use range from electrically operated horns or sirens to a gong similar to those on street cars.

Opinion is divided as to the necessity or desirability for a warning on cars of this kind. It is the preponderance of opinion that it is safer to put the entire responsibility on the operator of the motor car. The basis of this opinion is that the car will be handled more carefully if no warning is provided and danger points will be approached with the car under control, while with a warning device there would be a temptation for the operator of the car to sound the alarm and proceed expecting the way to be cleared.



Couplers for Maintenance Motor Cars.



SAFETY RAILS FOR MAINTENANCE MOTOR CARS.

The Committee has conducted a thorough investigation and finds only one or two States and municipalities have any legal requirements for warning signals for track cars. These regulations do not specify any particular device, the requirements simply being that they shall be provided with a bell, horn or whistle audible for a distance of 300 feet.

The necessity for some kind of an alarm on the car when passing over a road crossing is one of the principal arguments advanced in their favor. On the other hand those opposed to the general use of a warning device argue against it as tending toward the operation of the cars at excessive speed over crossings, the operator of the car relying on the alarm rather than proper precautions. It is also pointed out that with the large number of closed automobiles in use there is a serious question if audible signals of any kind are of much value. Proper precautionary measures both on the part of the operator of the motor car and driver of the automobile are to stop before proceeding over the crossing unless the view is unobstructed for a sufficient distance to avoid the possibility of a collision. It is, of course, recognized that there may be certain conditions under which motor cars are operated that would make it desirable or advisable to have some sort of a warning signal, as for example where tracks are laid in city streets. As a rule, however, it is the concensus that their general use is of doubtful value.

Gongs similar to those used on street cars and operated by hand or foot have been used quite extensively as alarms on track cars. The objection to a warning device of this kind is that in an emergency the hands of the operator are engaged in releasing belt tensions or clutches of engines and applying brakes while his feet are used to brace him. There is also the possibility of plungers and levers of bells becoming jammed or obstructed by tools or clothing of the men occupying the cars and thus preventing their proper operation.

The objection to the use of horns or sirens is that they may misdirect attention to automobiles on the highways rather than to the car; also that they must be operated by hand or foot. Electrically operated horns and sirens may fail when most needed in an emergency.

Whistles of the mouth blown type or their equivalent as used by police officers, crossing flagmen and by track gang foremen seem to be the most desirable type of alarm for track cars as they are useful not only to give warning of the approach of the car under conditions where such a warning is desirable but are useful also in warning track workmen of approaching trains and for giving signals of other kinds. These whistles should be suspended by loop cords around the neck of the operator or foreman where they may be accessible. They may be blown intermittently or continuously as desired and comply with the requirements that they be audible for a distance of 300 feet. The mouth whistle is distinctive which lessens the liability of its being confused with other types of alarm in common use.

Conclusions

(1) The use of warning devices on track cars is not recommended except under special conditions.

(2) Where desirable or advisable to use a warning device the mouth blown whistle of the type used by police officers furnishes the most efficient alarm for use on track cars.

Appendix D

(5) METHODS OF SCHEDULING AND ASSIGNING OF WORK EQUIPMENT, GIVING PARTICULAR ATTENTION TO EQUIPMENT USED IN SEASONAL WORK

J. B. Mabile, Chairman, Sub-Committee; O. L. Beydler, J. T. Derrig, Robert Faries, W. R. Gillam, R. A. Morrison, E. H. Ness, G. L. Sitton, F. M. Thomson, G. R. Westcott, Fred Zavatkay.

Your Committee takes the liberty to view and report on this subject from a standpoint of scheduling work instead of scheduling and assigning machines, the thought being, in order to keep machines at work the greatest number of days possible throughout the year, that the scheduling of non-seasonal work and work that can be considered non-seasonal (on which machines can be used), and programming the same so that machines would be available after seasonal work is finished (or as is often the case) such work can be done when machines are temporarily idle at intervals between seasonal jobs.

Each unit of work equipment represents a certain outlay of money and will last a given number of years and should be looked on as a man hired under contract for the same period of years at a fixed salary per year whether worked or not and every effort should be made to keep the machines going on all jobs on which they can save money.

The use of these machines is not confined to maintenance of way work and to keep the machines busy throughout the year and thereby affect maximum savings, departmental lines must be erased and the system officer in charge of the work equipment should work in close touch with the mechanical and other branches of the service, they keeping him advised as to their needs and he in turn arranging and notifying them when they can have the service required. This plan has been partially tried out on at least one railroad and it was found when maintenance machines were not required on maintenance work they have been used to advantage and have been the cause of effecting great savings in the Mechanical Department.

We have prepared a list of jobs that can be considered non-seasonal, on which these machines can be used (see Exhibit A). While this list is not complete and will vary on the different roads, some may not have all of these jobs while others will probably have work not shown in this statement.

We have prepared (see Exhibit B) a list of machines in most general use on all railroads reporting. The figures in Column 1 indicate the number of days that the different machines must be worked in order to return carrying charges, or in other words, they do not become money-savers until after working the number of days shown.

Column 2 shows the number of days seasonal maintenance work for the different machines.

Column 3 shows the number of days possible to expect from each machine.

Column 4 shows the number of days that machines are available for other than seasonal maintenance work.

Column 5 shows by number the non-seasonal or jobs that can be considered non-seasonal on which machines can be used. See Exhibit A for details.

The difference in number of days per annum machines can be used on seasonal work (Column 2, Exhibit B), and the possible number of days such machines are available (Column 3) which is shown (after deducting number of days necessary for repairs) in Column 4, indicates the possibilities for greater utilization of equipment and resulting economies by scheduling the non-seasonal work.

Conclusions

(1) Each machine must be operated a definite number of days before it becomes a profitable investment.

(2) Seasonal work should be programmed and machines so assigned as to reduce to a minimum the work done by hand or other methods.

(3) Non-seasonal work should be scheduled in order to utilize all machines the greatest possible number of days. The adaptability of the various machines for this class of work must be carefully considered.

EXHIBIT A

Job No.	Class or kind of work
1.	Breaking concrete or stone.
2.	Cleaning open wells.
3.	Cleaning hot wells.
4.	Coaling engines while chutes being overhauled.
5.	Cleaning and painting.
6.	Clearing main and yard tracks of snow and ice.
7.	Cutting ice at track pans.
8.	Dismantling retired rolling stock and buildings.
9.	Digging open wells.
10.	Disposing of rubbish at terminals.
11.	Disinfecting boarding houses, bunk cars and stock yards.
12.	Drilling holes in ties for spikes or lag screws.
13.	Excavating scale and turntable pits, etc.
14.	Erection of structural buildings.
15.	Electric lighting for tunnel and night work.
16.	Freight car construction and heavy repairs.
17.	Handling rail.
18.	Handling scrap.
19.	Placing drain or culvert pipe.
20.	Placing and removing screw spikes and lag screws.
21.	Running up and running off track bolts.
22.	Replacing gantry or overhead cranes needing repairs.
23.	Renewing decks on pile trestles.
24.	Special work around shops, stores and roundhouses.
25.	Spike driving.
26.	Setting pre-cast foundations, signals and battery wells.
27.	Transferring or shifting "Bad order" loads.
28.	White washing.

EXHIBIT B

Kind of Machine	(1) No. days per annum machine must work to return carrying charges	(2) No. days seasonal maintenance of way work per annum on which machines can be used	(3) Possible no. days per annum for each machine	(4) No. days available for non-seasonal work	(5) Work that can be considered non-seasonal
Steam Ditcher........	21	244	* 335	91	1-2-3-4-9-13-14-17-19-26.
Ballast Discer.......	8	183	183	-	-------------
Bonding Drill........	9	365	365	-	-------------
x 3/4 yd. steam or gas shovel caterpillar...	23	244	* 335	91	**1-2-3-4-14-17-19-22-24-26.
Madden Rail Layer....	10	365	365	-	-------------
Track Mower..........	8	153	153	-	-------------
Oil Spray............	23	122	365	241	5 and 28.
Portable Electric Rail Saw.............	100	365	365	-	-------------
Rail Loader - Air....	10	365	365	-	-------------
Rail Laying Crane....	30	365	* 335	-	19 and 23.
Tie Tamper (Air - old 4-tool)........	35	244	* 335	91	1-5-7-11-12-14-20-21-23-25-28.
Tie Tamper (Air- (8 and 12 tool)....	30	244	* 335	91	1-5-7-11-12-14-20-21-23-25-28.
Tie Tamper (Elec.)...	30	244	* 335	91	7-12-15-20-21-23.
Weed Burner..........	30	183	* 335	152	6.
Power Track Drill....	30	365	365	-	-------------
Tie Adzing Machines..	30	365	365	-	-------------
Paint Spray..........	40	365	365	-	11 and 28.
x Locomotive Crane.....	25	244	* 335	91	1-2-3-4-8-9-10-13-14-16-17-18-19-22-24-26-27.
Pneumatic Spike Driver	10	308	365	-	1 and 7.
Pneumatic Bolt Wrench.	13	308	365	-	12 and 23.
Electric Bolt Wrench..	13	308	365	-	12 and 23.
Track Raising and Shifting Machine......	37	183	* 335	-	-------------
Ditcher Spreader......	15	244	* 335	91	6 and 10.
Track Ballaster.......	20	180	250	-	-------------

* On the larger machines, to which all repairs cannot be made in field, we figure 30 days per year out of service for repairs.

** Machine equipped with crane boom will handle these jobs.

x Machines to be equipped with clamshell and dragline bucket, hook block and magnet to enable it to do the various jobs.

Appendix E

(6) METHODS OF KEEPING DATA ON WORK EQUIPMENT AND LABOR-SAVING DEVICES

Walter Constance, Chairman, Sub-Committee; J. F. Donovan, W. R. Golsan, P. R. Henderson, H. B. Hoyt, S. L. Mapes, R. A. Morrison, L. L. Parks, G. L. Sitton, J. B. Trenholm.

This assignment is a continuation of the work of Sub-Committee 10, of Committee XXII—Economics of Railway Labor, which Committee, in its report, page 1289, Volume 31, submitted as information, a number of forms suitable for the recording of such data.

Your Committee wishes to emphasize the statement of Sub-Committee 10, in its report, that "the major objective of keeping data on the performance of labor-saving devices is to determine whether economy may be effected through their use when compared with other methods of doing work."

It is also our opinion that the data obtained should develop information as to the efficiency with which the device is being handled and if it is being properly maintained.

Your Committee submits herewith various forms of performance reports as information for your consideration, believing that the exhibits serve only as examples of existing practice and that the character of the forms required on any particular railway is subject to the nature of the information desired by the officers in charge.

Exhibit A—Report for ditchers and drag lines.

Exhibit B—Report for mechanical tie tampers, provides for complete daily report from foreman, it also has an extension to be filled in by Cost Engineer or Supervisor. It includes hand tamping done in connection with machine work together with other information necessary in full analysis of the job.

Exhibit C—Report of ballast cleaner, with extension for completing the data.

Exhibit D—Report ...... power rail laying machine.

Exhibit E—Report showing performance of mowing machine.

Exhibit F—Report .... spreader ditcher.

Your Committee has made special inquiry as to reports on motor car performance and has received and considered a number of good forms. However, the forms in the Manual, as shown on pages 1468 and 1469, seem to meet the requirements as well as any.

Conclusion

Maintenance officers should continue to give careful consideration to the keeping of cost data, not only as to the comparative economy of machine and hand labor, but also for the purpose of developing the relative merits of different machines in the same class. We are of the further opinion that such records, properly kept, will be of benefit in securing the maintenance of equipment and in assuring its proper maintenance.

Exhibit A

PERFORMANCE OF DITCHER, DERRICK, DRAG LINE, ETC.

________ 19___ (Kind of Machine & No.)________

LOCATION (Station & Mile Post)	DESCRIPTION OF WORK ENGAGED IN Show work order etc.	FUEL, OIL AND OTHER SUPPLIES USED	NUMBER CARS OR CU. YDS. LOADED OR UNLOADED

TIME OF MACHINE CREW AND OTHER FORCES (Show Number of Each)

Work Train, Eng. No._____Cab No.______conductor____________________Locomotive

Engineer________________Worked from__________to______,____________H.____________M.

________Engineer worked from______to______&____to______,____________H.____________M.

________Fireman worked from______to______&____to______,____________H.____________M.

________Foreman worked from______to______&____to______,____________H.____________M.

________Laborers worked from______to______&____to______,____________H.____________M.

________________worked from______to______&____to______,____________H.____________M.

________________worked from______to______&____to______,____________H.____________M.

Remarks:____

Note: This report to be made up and mailed at the close of each day to the Division Engineer, with copy to Roadmaster or Supervisor under whom employed. Want full explanation of all overtime and delays. Show average load of cars in cubic yards. Also want under REMARKS, material and labor for repairs.

Operator__________________

EXHIBIT–B

THE A.B.& C. RAILWAY COMPANY

RECORD OF MECHANICAL TIE TAMPING OPERATIONS

DIVISION________________________ ________________ASS'T. COST ENGINEER

DISTRICT________________________ ________________FOREMAN

ATE	GAS GALS.	OIL PINTS	HOURS IN SERVICE	MAN HRS. MOVING OUTFIT	NO. FEET MECH. TAMPED		MAN HRS. FILLING IN BALLAST	OTHER MAN HOURS WITH TAMPERS		NO. FEET HAND TAMPED		MAN HOURS HAND TAMPING		NO. OF TIES MECH. TAMPED		NO. OF TIES HAND TAMPED		AVERAGE LIFT IN INCHES		MAN HOURS ON OTHER WORK					TOTAL MAN HOURS
					1st.	2nd.		1st.	2nd.	1st.	2nd	1st.	2nd.	1st.	2nd	1st.	2nd.	1st.	2nd.	BALLAST	LINE AND SURFACE	TIES	BANKING AND DITCHING	MISCL.	
1																									
2																									
3																									
4																									
5																									
6																									
7																									
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31																									
TAL																									

NOTE If tamping outfit is not used during month notify this office accordingly, giving machine number with explanation.

THE A.B. & C. RAILWAY COMPANY

SUMMARY

_______________TIE TAMPING MACHINE No.__________

MONTH__________TRACK_________M.P.____To M.P.____

Cost of Gasoline----------(____x $0.___)----------_____
Cost of Oil----------(____x $0.___)----------_____
Hours in service----------_____
Man hours moving outfit----------_____

Man hours filling in ballast----------_____
Number of feet of first raise mechanically tamped----------_____
Number of feet of second raise mechanically tamped----------_____
Man hours per foot of first raise mechanically tamped----------_____
Man hours per foot of second raise mechanically tamped----------_____
Cost per ft. of first raise mechanically tamped---(____x $0.___)---_____
Cost per ft. of second raise mechanically tamped-(____x $0.___)---_____

Number of feet of first raise hand tamped----------_____
Number of feet of second raise hand tamped----------_____
Man hours per foot of first raise hand tamped----------_____
Man hours per foot of second raise hand tamped----------_____
Cost per foot of first raise hand tamped---(____x $ 0.___)-----_____
Cost per foot of second raise hand tamped--(____x $ 0.___)-----_____

Number of ties mechanically tamped – 1st. Raise----------_____
Number of ties mechanically tamped – 2nd Raise----------_____
Number of ties hand tamped – 1st. Raise----------_____
Number of ties hand tamped – 2nd Raise----------_____

Average inches of lift – 1st. Raise----------_____
Average inches of lift – 2nd Raise----------_____

Final cost per foot of track (excluding repair costs)----------_____
Estimated final cost per foot of track by hand-(____x $0.___)--_____

Repairs to tamping outfit---Labor $_____+ Mtl. $_____----_____
Average feet per day machine worked----------_____

____
Ass't Cost Engineer

EXHIBIT-C

DIVISION.............................. ASST COST ENGR

SUB-DIVISION.............................. FOREMAN

THE A.B. & C. RAILWAY COMPANY

MAINTENANCE OF WAY DEPARTMENT

REPORT OF PERFORMANCE OF BALLAST CLEANER NO.____

MONTH.................... TRACK.................... MP.......... TO MP..........

DATE	NO. OF HOURS IN SERVICE	MAN HOURS WORKING MACHINE	LIN FT. OF CENT. DITCH CLEANED	CU. YDS. OF BALLAST CLEANED	GASOLINE GALLONS	OIL-PINTS VALVE	OIL-PINTS CYLINDER	GREASE LBS.	REPAIRS TO MACHINE MAN-HRS.	REMARKS
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
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24										
25										
26										
27										
28										
29										
30										
31										
TOTAL										

SUMMARY

Average Depth of Center Ditch Cleaned..............................

Linear Feet of Center Ditch Cleaned..............................

Cubic Yards of Ballast Cleaned..............................

Cost of Gasoline..........(____ x $____)..............................

Cost of Oil..........(____ x $____)..............................

Cost of Grease..........(____ x $____)..............................

Cost of Labor..............................

Total Operating Cost..............................

Cost per Linear Foot of Center Ditch..............................

Cost per Cubic Yard of Ballast Cleaned..............................

Cost of Repairs - Labor..............................

Cost of Repairs - Material..............................

NOTE:
No repair costs are to be included in items, Cost per Linear Foot and Cost per Cubic Yard Cleaned.
When repairs are made, all parts shall be listed

Exhibit D

PERFORMANCE REPORT OF RAIL LAYING MACHINE

__________Division __________19____Machine No.__________

		:This :Month	: To-Date
Location From M.P.________	to M.P.________		
" ________	" ________		
" ________	" ________		
" ________	" ________		
" ________	" ________		
" ________	" ________		

Lineal Feet - Laid__________ Weight of Rail__________

Number of days operated__________ Length per rail__________

	Man Hours	Cost
Machine Operator.	________	________
Ground Men Operating with Machine	________	________
Adzing Ties	________	________
Other work in connection with laying rail	________	________
Foreman	________	________

Expenses		Gallons	Unit Cost
	Gasoline	______ c	________
	Lub. Oil	______ c	________
	Black Oil	______ c	________
	Waste, etc.	______ c	________

TOTAL - __________

Cost of repairs . . . . $ ________

Total - __________

Average No. of men work daily ________

" Foreman " " ________

Show total number of men hours included in above, charged account of travel "to" and "from" work. . . . . ________

Note: Must not include hours unloading, loading and uncoupling rail.

Exhibit E

PERFORMANCE OF MOWING MACHINES

_______________ Division _______________ District _______________ 19___

_______________ (Kind of Machine _______________ Machine No. _______

- -

(a) Location From M.P. _______________ to M.P. _______________
" " " _______________ " " " _______________
" " " _______________ " " " _______________
" " " _______________ " " " _______________

(b) Number of miles of swath cut _______________

(c) Number of days operated _______________

(d) Number of men working (Ave. per day) _______________

(e) Supplies
Gasoline _______ Gals. @ _______ $ _______
Lub. Oil _______ " @ _______ $ _______
Other _______ " @ _______ $ _______ $ _______________

(f) Labor
Foreman _______ Hrs. @ _______ $ _______
Laborers _______ " @ _______ $ _______
" _______ " @ _______ $ _______ $ _______________

(g) Repairs $ _______________

(h) Total cost to operate...$* _______

(i) Average cost per mile...$ _______

(j) Average cost per mile to do same work by hand..........................$ _______

REMARKS: ____

____

____

____
Division Engineer

Exhibit F

REPORT OF PERFORMANCE OF SPREADER DITCHER

__________ Division Date__________

District__________ Spreader No.__________
From M.P.__________ to M.P.__________ Locomotive No.__________

Details

Lin. Ft. ditch in cut completed______	Work train______
" " " " open " ______	Engineer______
Average length haul in feet ______	Fireman______
Yardage moved______	Conductor______
	Flagman______
Actual hours ditching______	Brakeman______
Actual hours spreading______	Roundhouse labor______
Actual hours other work & kind______	Coal______
	Water______
Total hours worked______	Oil and tallow______
	Other expenses______

Actual hours delay clearing trains______

Actual hours delay other causes and kind______

Total hours delay______ Total work train expense______

Hours on duty - Train crew______ Operator's salary______
Hours on duty - Operator ______

Total all expense______

Cost per lin. ft. of ditch______
Cost per cu. yd. moved______

Note: Render report for each working day, and whenever machine is out of service, daily report will show why.

Signed: Approved:

__________ __________
Ditcher Operator Division Engineer

Appendix F

(9) ORGANIZATION FOR USE AND MAINTENANCE OF TIE TAMPING MACHINES—AIR AND ELECTRIC

L. B. Holt, Chairman, Sub-Committee; W. O. Cudworth, J. T. Derrig, Wm. Elmer, Robert Faries, R. J. Gammie, S. L. Mapes, A. J. Neafie, L. L. Parks, F. M. Thomson, G. R. Westcott, J. B. Trenholm.

After reviewing information as to practices of railroads using tie tamping machines your Committee has reached the conclusion that, generally speaking, there are few fundamental differences in the methods employed.

It is felt that it will be best to make a concise statement of what appear to be the best standards to follow and then each railroad can apply them with such modifications as their individual requirements dictate.

Tie tamping machinery has been in service since 1913, in which year the first successful pneumatic unit, consisting of a single cylinder portable compressor and two tampers, was employed. In succeeding years progressive improvements have been made until now we have as standard, four, eight, twelve and sixteen tool pneumatic and four, six, eight and twelve tool electric outfits.

Efficient and economical results with tie tamping machinery can only be accomplished when the mechanism is in good working order and manned by reliable men under the direction of a competent foreman.

Following is a statement of what appears the best balanced gang organizations for good, economical surfacing work, with the most commonly used units, namely, the four, eight and twelve tool outfits of either pneumatic or electric type. These organizations are designed for surfacing work only, excluding labor for spacing and renewing of ties as such work is outside the scope of this subject. When tie spacing and renewals are involved such additional men as may be required can be added to the organizations shown.

Organization of Gang for Operating Four Tool Outfits

1 foreman
1 machine operator and handyman
4 men on tampers
1 man on jacks; also change off on tampers
2 men handling ballast and hose or electric cables; also change off on tampers
—
9 men

Organization of Gang for Operating Eight Tool Outfits

1 foreman
1 machine operator and handyman
8 men on tampers
2 men on jacks; also change off on tampers
2 men handling ballast and hose or electric cable; also change off on tampers
1 man dressing off ballast
1 water boy
—
16 men

Organization of Gang for Operating Twelve Tool Outfits

1	foreman
1	assistant foreman
1	machine operator and handyman
12	men on tampers
4	men on jacks; also change off on tampers
2	men cleaning out ballast ahead of tampers
2	men forking ballast; also change off on tampers and handle hose or electric cable
1	water boy
24	men

Ordinary maintenance of tie tamping machinery during the operating season, such as greasing, oiling, cleaning, renewing spark plugs, flushing radiator, oiling tampers, changing gaskets, etc., should be handled by the operator who should be selected because of his aptitude along mechanical lines.

More complicated field repairs should be taken care of by the Division Mechanic who normally cares for gas engines, motor cars, etc. He must make regular and systematic inspection of all tamping outfits under his jurisdiction and be responsible for the successful operation of same.

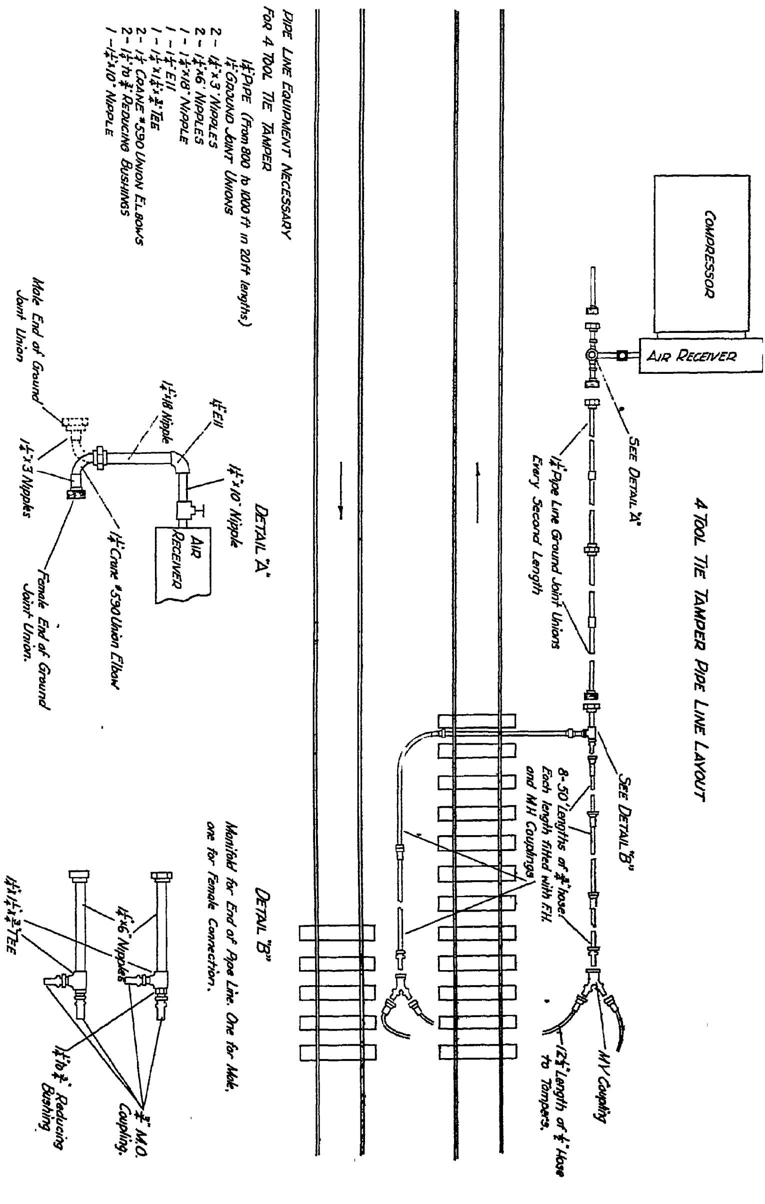
At the close of the operating season the complete tamping outfit, including tools, should be sent to the Division or Centralized Shop where it should be gone over thoroughly by competent mechanics who will replace or repair all defective parts, clean the equipment thoroughly inside and out and after painting, store same under suitable cover until needed in the spring.

During the winter overhauling of tamping outfits special attention should be given to the tamping guns. This would include a thorough test to determine whether they are in efficient working condition or whether the pistons and cylinders are so worn that they are not giving profitable service. Guns in normal condition should use about 17 cu. ft. of air per minute and when the test indicates that the guns use 22 or more cu. ft. per minute they should either be replaced or the cylinders should be re-ground and over-size pistons applied so as to restore the efficiency of the tool.

The Division or Centralized Shop should be located adjacent to a side-track so that tamping equipment can be readily unloaded from and re-loaded into cars. The Shop should be equipped with necessary machine tools requisite for ordinary maintenance repair work and hoists, either hand operated or electrical, should be provided to facilitate the work.

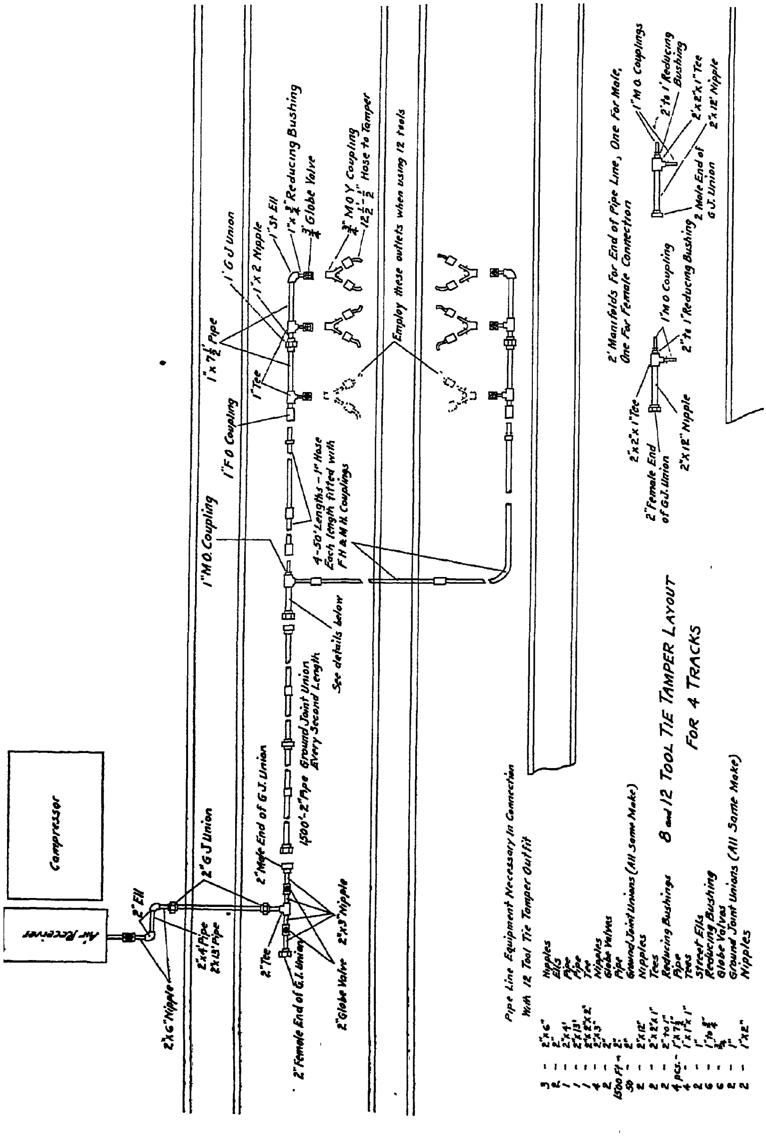
If the compressing or generating units, as the case may be, require unusually heavy repairs or replacements it is usually best to return this equipment to the manufacturer who is better equipped to take care of any essential work and restore the outfit to its original state of efficiency.

Suggested Pipe Arrangement for Four Tool Pneumatic Outfits



Suggested Pipe Arrangement for Eight and Twelve Tool Pneumatic Outfits as Used on Four Tracks

(With slight modification can also be used for two tracks)



Appendix G

(11) CARE OF WORK EQUIPMENT WHEN NOT IN USE, WITH PARTICULAR REFERENCE TO PROPER HOUSING

E. Pharand, Chairman, Sub-Committee; Walter Constance, C. E. Miller, E. H. Ness, S. H. Osborne, J. G. Sheldrick, Harry Slabotsky.

Your Committee has investigated the care of work equipment when not in use in considerable detail. The general practice on most roads appears to be that large equipment, such as shovels, cranes, pile drivers, etc., should be thoroughly drained and shipped into winter quarters when not in service. The machines can then be inspected and reconditioned, after which they should be boarded up or otherwise protected to prevent pilferage of parts or damage by unauthorized persons. Parts subject to rust should be coated with a suitable inhibitor to prevent damage from this source. The machines may then be stored in the division shops, on storage tracks or in sheds suitable for this purpose. The switching about of large equipment during periods of idleness often results in damage to the machines and for this reason they should not be stored on used tracks.

Smaller equipment, such as motor cars, tie tampers, concrete mixers, ballast machines, pumps, spike drivers, lag screw wrenches, air drills, tie tamper guns, weeding machines, bolt tighteners, paint spray equipment, ballast discers, adzing machines may be sent into division shops. Repair reports should then be submitted covering repairs required to each machine which may be given a general overhauling if needed, after which they may be stored in tool houses, mechanical shops, tool cars or special sheds provided for the purpose to protect them from the elements. If the above is not possible the machines should be covered with water-proof material and well greased to prevent them from rusting.

The use of gasoline cranes and air compressors has increased to such an extent that many of these machines are in service on bridge or dock work during the winter and on rail laying with tamping equipment during the summer months with comparatively few in storage. When air compressors are at work on a bridge or dock job of considerable duration, during the winter months it is customary to house them in a cheaply constructed house provided with heat.

The methods used for the prevention of rust and corrosion and care of parts appears to be general on all roads. The bearings, pistons, crank shafts, connecting rods, etc., are usually given a coat of medium grade cup grease. This also applies to parts carried in stock. For gasoline engines and air compressors, a mixture of regular gas engine oil with cheaper grade oils may be used to good advantage.

The question of insurance on equipment was discussed by this Committee but this item cannot be properly considered until such times as railways assign tracks, shops or housing for this particular type of equipment.

Conclusions

(1) It is essential to drain boilers, water reservoirs and tanks on equipment when not in use. Plugged openings should be installed in the equip-

ment for this purpose, and the holes properly rodded when plugs are withdrawn to assure complete drainage.

(2) The use of oils, greases and anti-corrosive preparations is urged in view of the great saving effected in the prevention of rust and corrosion by this protection when equipment is in storage.

(3) The assignment of track space or sheds for heavy equipment is strongly urged in view of the saving that may be effected by not having the equipment unnecessarily switched.

Appendix H

(12) STANDARD COLORS FOR WORK EQUIPMENT AND MOTOR CARS

F. S. Hewes, Chairman, Sub-Committee; O. L. Beydler, W. O. Cudworth, W. R. Golsan, H. B. Hoyt, J. B. Mabile, A. J. Neafie, S. H. Osborne, Philip Petri, J. G. Sheldrick.

In making a study of the subject assigned, the Committee first divided the work equipment into two classes, designating them as light work equipment and heavy work equipment, which with the motor cars, makes three classes to be considered.

Under motor cars the Committee includes motor cars for inspection purposes, for section gangs, bridge and extra gangs, etc. (not including motor cars engaged in passenger or transportation service).

Light work equipment includes weed mowers, adzers, power jacks, air compressors, electric tampers, etc.

Heavy work equipment includes steam shovels, spreaders, cranes, crawlers, and work equipment operating on M.C.B. trucks.

To ascertain the practice now followed by various railways, a questionnaire was sent to one hundred and sixty officials, who are members of the American Railway Engineering Association, asking for information as to the colors of work equipment and motor cars, on the roads with which they are connected.

Replies representing practically all of the larger railways in the United States and Canada, were received and a tabulation of the colors now in use and of the colors recommended for use on motor cars, light work equipment and heavy work equipment was made up from these replies, as follows:

	Motor Cars		*Light Work Equipment*		*Heavy Work Equipment*	
Color	*In Use*	*Recommended*	*In Use*	*Recommended*	*In Use*	*Recommended*
Red	32	27	13	14	21	17
Yellow	28	31	17	22	2	5
Green	6	6	1	1	1	0
Gray	1	1	4	2	2	1
Black	0	0	11	12	49	44
Color not given	14	11	30	22	15	13

The designation "red" includes not only those colors that are strictly red, but also so-called brown colors, such as brown mineral and box car red. Likewise "yellow" includes all shades of yellow, from the lighter color such as lemon, through the medium to the darker shades, such as orange.

The above table shows that red and yellow are the predominating colors now in use and recommended for use on motor cars and light work equipment with black the predominating color for heavy work equipment.

Another source of information investigated by the Committee consisted of a canvass of motor car and work equipment manufacturers. The result of this canvass shows, with one exception, all manufacturers recommending the colors which they are now using, the one exception being the recommendation for the use of orange yellow, made by one manufacturer who is now using battleship gray.

A tabulation of the replies from these manufacturers, when the color is not specified by the purchaser, shows results as follows:

	Motor Cars		*Light Work Equipment*		*Heavy Work Equipment*	
Color	*In Use*	*Recommended*	*In Use*	*Recommended*	*In Use*	*Recommended*
Red	3	3				
Yellow	1	1	3	4		
Green			1	1		
Gray			3	2	3	3

If any one color is to be adopted as recommended practice for use on each class of equipment covered by the subject assigned to this Committee, the choice of color should rest upon some justifying reason.

Some railway officials recommend the use of a red color on motor cars and light equipment because it is the color of a stop signal. Others recommend the use of a yellow color because it is the color of a caution signal. The question at once arises as to whether or not it is desirable to make a stop signal of a motor car or piece of work equipment. In a very large majority of cases when a train approaches a motor car, or other light work equipment, the motor car or work equipment either is in the clear or will be before the train reaches it, therefore, the color of the car ceases to be a signal. In the few cases where such equipment is not in the clear, the operator should use a red flag to signal the train to stop, and unquestionably a red flag can be seen much more clearly against any other background than it can against a red background. For this reason it is the opinion of the Committee that a red color should not be used for motor cars or other work equipment.

The other most favorably considered color is yellow for motor cars and light work equipment and the Committee believes a medium shade to be the best all around color for this purpose. The Committee appreciates that a first quality yellow paint will cost slightly more than the average grade of brown mineral or box car red paint, but thinks this small increase will be more than offset by the better visibility and general appearance of the equipment. The service life of the yellow paint compares favorably with the reds and browns.

Black is recommended by the majority of the railways for heavy work equipment and this seems well taken from the standpoint of general practice and serviceability.

In recommending colors for use on motor cars and work equipment, the Committee recognizes that those metal parts of the various machines which are largely covered by the ends and body of the machine, or where subjected to considerable heat, should be painted black or some other suitable color.

In light of the above information the Committee offers the following conclusions for the predominating colors:

Conclusions

The most suitable colors for use on motor cars and work equipment are as follows:

For motor cars.................Yellow (medium chrome)
For light work equipment........Yellow (medium chrome)
For heavy work equipment.......Black

The Committee recommends the adoption of the conclusions for publication in the Manual and that the subject be discontinued.

Appendix I

(14) STANDARDIZATION OF VOLTAGE AND KIND OF CURRENT FOR USE IN ELECTRICALLY OPERATED MACHINES AND TOOLS FOR ROADWAY PURPOSES

P. R. Henderson, Chairman, Sub-Committee; O. L. Beydler, E. L. Christoph, J. F. Donovan, L. C. Hartley, Jack Largent, L. L. Parks, G. L. Sitton, F. M. Thomson.

This subject was originally assigned to Committee XXII—Economics of Railway Labor, who presented a report in March, 1930. The report was referred back to Committee XXII—Economics of Railway Labor for further study and reassigned to this Committee by the Board of Direction.

The former committee reporting on this subject gave the matter a great deal of study and the report as submitted contained the views of both manufacturers and users. In addition to this the Committee also had the benefit of the co-operation of Committee XVIII—Electricity, whose report on the subject follows:

"It does not appear desirable to recommend definite standards at this time, for the following reasons:

"1. In general, commercial electric power is not available for operating roadway tools. Even if available, it may be D.C. or A.C. and of varying voltages and frequencies and number of phases.

"2. Ordinarily, it is too expensive to extend special power circuits to supply energy for operating portable roadway tools. Even if practicable, the form of energy would vary, as to type of current (D.C. or A.C.), voltage, frequency and number of phases.

"3. Power may be available by using portable gasoline engine generator sets, etc., but such sets are generally designed for special purposes.

"4. On electrified railroads, power may be available at the voltage and frequency of the third rail or overhead trolley system. Such power may be either D.C. or 25 cycle A.C.

"5. Different types of tools require different kinds of electrical energy for most practicable and efficient operation.

"There are two general considerations which control the choice of voltage, phase and frequency of electric power to be used for driving roadway tools, viz.:

"1. The form in which power is available at the points where roadway tools are to be used.

"2. The type of electric power which is best fitted for the work to be done, from the standpoint of practical and economical design of electrical equipment on roadway tools.

"Power from generating stations, or railroad sub-stations, may be available in one of the following forms:

"115 volts, single phase, A.C. 60 cycle or 25 cycle.

220 volts, three phase, A.C. 60 cycle or 25 cycle.
440 volts, three phase, A.C. 60 cycle or 25 cycle.
115 volts, direct current.
230 volts, direct current.
650 volts, direct current.

"The most commonly available voltage commercially is 115 volts, 60 cycle, single phase, alternating current. For portable hand tools requiring motors of approximately ¼ H.P. or less, it is desirable to adopt 115 volt "Universal" motors which can be operated on either alternating current or direct current circuits.

"For A.C. equipment requiring motors between approximately ¼ H.P. and approximately 2 H.P. single phase, 115 volt motors are preferable.

"For equipment requiring motors larger than the approximately 2 H.P. 220 volt, three phase motors are preferable, although satisfactory single phase motors up to 10 H.P. may be used, if that form of power is available.

"Three-phase alternating current power at 440 volts is less common than at 220 volts, and it is believed that there is little reason for considering 440 volts for roadway work. However, it is a standard 60-cycle voltage which is available at many points on railroads, and this form of power should not be excluded for special requirements.

"Direct current distribution is becoming more and more uncommon but is still a standard voltage at many shops and enginehouses, so that a few direct current motors are now used and will be used for some time to come in roadway work.

"On roadway machines equipped with self-contained power plants, such as cranes, portable gasoline engine driven generator sets, etc., the kind and voltage of power must be determined by the work to be done. On cranes which may be used with electric magnets, the electrical equipment preferably should be designed for 230-volt direct current. Where lighting only is desired, it is often desirable to use direct current turbo-generators, with voltages as low as 32 volts. The characteristics of gasoline engine driven generators may be 25-cycle alternating current of a suitable voltage for use with rectifiers to operate electric tie tampers and other portable tools, as developed by one manufacturer. Portable welding outfits must be designed for approximately 60-70 volts direct current.

"In industrial work, it has not been found possible or desirable to standardize voltage and type of current, because each of the various forms of electric power which are in use have marked advantages over other forms for the particular work to be done. It is possible to work toward a number of standards, and the most common standards are 115 volts, 60-cycle, single phase, alternating current for lighting and for driving small motors; 220 or 440 volts, 60-cycle, three-phase alternating current for motors on the majority of machine tools; 230 volts direct current for certain variable speed machine tools; 60-volt direct current for welding.

"It does not seem practicable, for the present, to attempt to hold to these same or any other standards, for the reasons outlined above."

It is evident from the discussion on the floor of the convention that the members were under the impression that the standardization of electric current as used in roadway machines was a matter to be settled with the manufacturers of the equipment.

It may be well to explain that the matter of standardization of electric current is not in the hands of the manufacturers of roadway machines and tools. Almost without exception they favor standardization. These manufacturers are compelled to produce electric tools and machines to operate on the various kinds of power provided by commercial power companies as well as privately owned power plants. These different kinds of power vary

from 220 to 2200-volt, three phase, 60-cycle or 25-cycle alternating current, 115 volts, single phase, 60-cycle or 25-cycle alternating current and from 32 volts to 650 volts direct current.

It is, therefore, apparent that effort toward the standardization of electric current should be directed toward the commercial power companies and privately owned power plants with a view of having them work to a standard. Unfortunately this would not be practical in all cases as various kinds of electrically driven equipment requires various kinds of power.

Large power motors are usually built to operate on high voltage alternating current up to 2200 volts. The reason for this is that as the voltage increases the amount of copper required to carry the current is decreased, thus effecting material savings in transmission of power.

Small power motors cannot be designed successfully for operation on high voltages and are therefore usually built for operation on alternating or direct current, 220 volts or less. The reason for this is that the problem of insulation in these small motors is a difficult matter with high current on account of the limited space available. Small portable motors, as for example those used in operating drills and power saws, must be built for operation on low voltages not only on account of the problem of insulation but also in the interests of safety.

As stated by the Committee on Electricity, the use of direct current is decreasing. Variable speed motors, particularly of the larger sizes, are much more flexible when operated on direct current. Therefore, direct current is still used in a great many cases and will no doubt continue to be used instead of alternating current although the latter is easier and more economical to transmit. Street railways are an excellent example of the prevailing use of direct current.

Motors for use on lighting circuits must be made to operate on 115 volts, single phase, A.C. or D.C., as these voltages are widely used. For this reason 115-volt A.C. single phase, 60-cycle current is fast becoming universal for lighting circuits and is well adapted for small motors up to 2 horsepower. For larger motors 220-volt, A.C., 3 phase, 60-cycle current is more desirable, and efforts toward standardization of power for ordinary purposes will undoubtedly be made to adopt these current characteristics.

We will always have to contend with different power characteristics in connection with roadway machines and tools as certain work and certain machines require current of special characteristics, as for example certain machines of the impulse type where 25-cycle alternating current is essential; 25-cycle A.C. current is also used in operating low speed motors. Other purposes requiring special current characteristics are welding and plating as high voltages cannot be used successfully, high currents and low voltages being required.

Conclusions

(1) Electric current generated by commercial and privately owned power plants varies widely, ranging from 115 volts to 2200 volts, 3-phase, both 25 and 60-cycle, while direct current ranges from 32 volts as used on passenger equipment to 650 volts direct current.

(2) Manufacturers of electrically driven roadway machines and tools are in favor of standardization of current characteristics except in tools of the vibrating or impulse type and electric welding.

(3) The voltage most commonly available commercially is 115-volt, 60-cycle, single phase alternating current as used on lighting circuits, and 220-volt, 3-phase, 60-cycle current is most commonly used on power circuits.

(4) That 115-volt, single phase, 60-cycle alternating current is recommended for roadway tools and machines, 2 H.P. and less, and that 220-volt, 60-cycle, 3-phase alternating current is recommended for machines requiring more than 2 H.P.

Appendix J

(15) BEST PRACTICE OF MAINTAINING LABOR-SAVING DEVICES ON CONSTRUCTION AND MAINTENANCE OF WAY WORK, AND THE ORGANIZATION OF THE NECESSARY SUPERVISORY FORCE

C. H. R. Howe, Chairman, Sub-Committee; J. F. Donovan, W. N. Eddens, R. J. Gammie, L. C. Hartley, S. L. Mapes, R. A. Morrison, S. H. Osborne.

This subject was originally assigned to Committee XXII—Economics of Railway Labor, who reported on the subject March, 1930. The subject was referred back to the Committee by the convention and reassigned to this Committee by the Board of Direction.

The chief objection to the report as submitted was based upon the recommendation of the Committee that the maintenance of way work equipment not covered by M.C.B. rules should be concentrated in shops entirely independent of the Mechanical Department and under an organization controlled by the Maintenance of Way Department, and while the report given below follows the same general lines as the one submitted by the former Committee the recommendations as to the shops have modified to conform to the views of the members as expressed at the last convention.

"The term 'labor-saving devices' covers many different kinds of equipment used in maintenance of way work on railroads, and applies to roadway machines, small tools, and work equipment, as included in the Interstate Commerce Commission Classification.

"There is no well-defined line of demarcation between Roadway Machines (Account 37), Small Tools (Account 38), and Work Equipment (Account 57), as covered by the Interstate Commerce Classification, and as a result there is in all probability a wide difference in the interpretation as to which account certain machines should be charged, depending largely on the judgment of the individual.

"In making recommendations as to methods of maintaining this equipment, your Committee has assumed that labor-saving devices as covered by the assignment refers to all equipment used in railway construction and maintenance, not covered by M.C.B. rules, except roadway small tools as classified in Account 38.

"The maintenance force on motor cars and other labor-saving equipment can be consolidated with few exceptions. In many instances the existing force of motor car maintainers may be able to handle this work without additional force.

"Maintenance of work equipment may be divided into three general classes: (1) Ordinary running repairs, or field maintenance, (2) General repairs at shops, (3) Emergency repairs due to break-downs.

"Running repairs, or field maintenance, include proper lubrication, adjustment of moving parts, packing, and renewal or replacement of minor parts of the machine; work which can be performed in most instances by a competent operator without taking the equipment out of service.

"General repairs, or overhauling, should be necessary only at the end of the working season. A great deal of the work done by labor-saving equipment is seasonal, and repairs may be made at such time as will not interfere with operation during working season. Where equipment is used throughout the year it should be taken out of service for repairs at such time as will cause the least inconvenience or interruption to the working schedule.

"The proper operation and maintenance of equipment in the field is an important factor in controlling the general repairs, as well as extending the periods between shoppings. Proper field maintenance will also materially lessen the liability of breakdowns and accidents necessitating emergency repairs. These breakdowns will, of course, occur even with the most careful operation and field maintenance. Such failures should be anticipated so far as possible, and a reasonable stock of spare parts kept on hand at all times."

Maintenance of Way Shops Desirable

The general practice followed in maintaining labor saving equipment is to establish shops under the jurisdiction of the Maintenance of Way Department. This is very desirable where there is sufficient work to justify the maintenance of separate shops. Labor-saving equipment consisting of the various types of roadway machines and tools requires men especially trained in maintaining internal combustion engines, automotive and electrical equipment.

Shops under the jurisdiction of the Maintenance of Way Department also offer advantages in training apprentices and operators of work equipment. Even on the smallest railroad there is sufficient work to warrant a special organization for the upkeep of maintenance of way labor-saving equipment.

The method of maintaining labor-saving equipment, together with the organization and supervisory forces, should follow closely the general scheme for the maintenance of motor cars as outlined in the report of Committee XXII—Economics of Railway Labor, pages 1020-1036, inclusive, Volume 27, Proceedings.

In many instances, shops have already been established for maintaining all work equipment, and where such facilities are not provided they can be consolidated with existing facilities for maintaining motor cars, as where motor cars are maintained there is always a nucleus of an organization for handling all maintenance of way equipment.

The question of proper location of shops involves two opposed problems: (1) centralization, with long haul and delay in handling equipment to and from shops for repairs; and (2) decentralization, with its duplication of machinery and equipment and possible loss of efficiency and economy through the necessity of employing specialized labor where each shop is located.

So far as maintaining labor-saving equipment alone is concerned, it will be desirable to have shops located on each grand division in order to reduce

supervisory force and shop equipment required. However, where there are sufficient motor cars to justify, maintenance of way shops may be located on each division. Therefore, the same policy in regard to location of motor car shops for maintenance of way equipment should be followed as in the case of motor cars, combining the facilities where practicable.

There are various factors to be considered in the location of these shops. The principal feature is the location of the work equipment, as it is desirable to avoid shipping the equipment any considerable distance. Other factors are, location of storehouses, reclamation plants, and division office.

Tools and Equipment

It is impossible to prepare a list of tools, machinery and other equipment essential to the maintenance of work equipment that will fit all roads and all conditions. The list of machines and tools shown in last year's report, page 1321, Proceedings, 1930, will be useful in the ordinary maintenance of way shop.

No attempt has been made to list all of the small miscellaneous hand tools which are common to the average motor car repair shop. These must be selected to meet the individual needs. Many of them are owned by repairmen. A list of small tools for motor car repair shops is given in report of Committee XXII—Economics of Railway Labor, page 1036, Volume 27, Proceedings. The tools specified are also adapted to use in maintaining other equipment.

In selecting maintenance of way shop equipment, careful survey should be made of actual requirements. For example, a 24-inch lathe might not be suitable for all shops. The same is true of a combination woodworking machine; although a machine of this type can be justified in almost any division, as it is of equal value to the carpenter forces in framing lumber for both repairs and construction, including sash and door work.

The proper supervisory force will depend upon the amount of equipment involved. For example, a 10,000-mile railroad fully equipped with work equipment would require a general supervisory force consisting of a Superintendent of Work Equipment and four assistants; a 5,000-mile railroad, a superintendent and two assistants; while on a railroad of say 2,000 miles the work could probably be handled by one man. In each case, sufficient office force should be provided for keeping accurate records of maintenance and operation costs, and of the performance of equipment.

It is advisable to have a traveling maintainer on each division, regardless of whether shops are located on the division or on grand divisions. The number of mechanics required in the shops will depend upon the amount of equipment to be cared for. As a rule it will rarely be necessary to materially increase the existing force where motor cars are already maintained, for the reason that much of the work of repairing equipment can be carried out during the winter months when the repairs to motor cars are materially reduced. Where they can be used to advantage, operators should be employed in shops during the winter months, both in order to afford continuity of employment and to complete their training as operators. Adequate power-driven equipment in the repair shops should materially reduce the number of men required.

The Superintendent of Work Equipment should report to the Engineer Maintenance of Way or chief system maintenance officer, and should have jurisdiction over the division maintenance, jointly with the Division Engineer or principal division maintenance officer, and have direct jurisdiction over system maintenance of way shops. The headquarters should preferably be at the same location as the Engineer Maintenance of Way, and, as previously stated, clerical force should be assigned as may be necessary for keeping records, cost of operation, maintenance, and performance of all equipment.

An important feature in the success of maintaining labor-saving and other maintenance equipment is the co-operation of the Supply Department. It is of utmost importance that an adequate stock of repair parts be readily accessible, preferably where shops are located.

The adoption of labor-saving equipment by railroads has not in all cases been followed by the proper maintenance facilities. The maintenance of way shops are often inadequate, consisting of old car bodies or discarded shanties with very few tools and practically no equipment. It is false economy to depend upon shops of this type and the maintenance facilities should be developed and expanded to take care of the maintenance of additional equipment as it is placed in service. In many instances it may be necessary to relocate the existing shops.

Organization charts of suggested supervisory force are shown herewith.

Conclusions

(1) In order to avoid interruption to working schedules and to lengthen the intervals between shop overhaulings, particular attention should be given to running repairs and field maintenance.

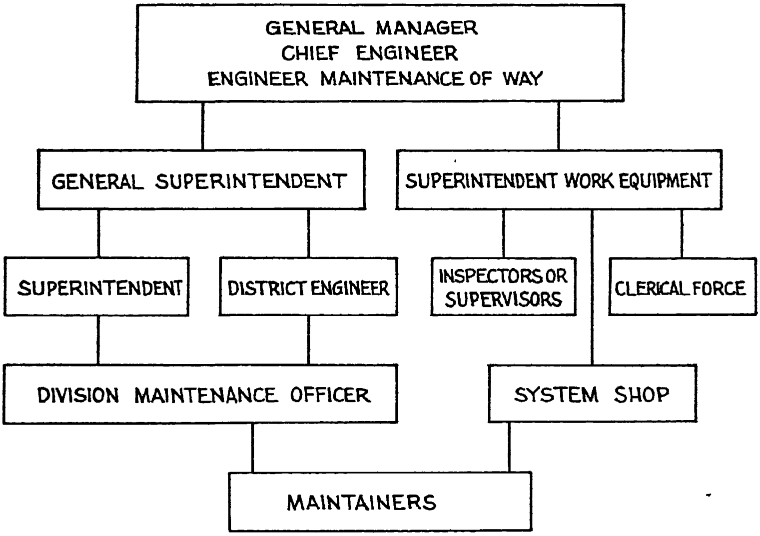
(2) An adequate supervisory force should be employed to insure proper maintenance of work equipment, both in field and shops.

(3) Where there is sufficient work to justify, it is preferable that the maintenance of equipment not covered by M.C.B. rules should be concentrated in shops controlled by the department that is responsible for the operation of the equipment.

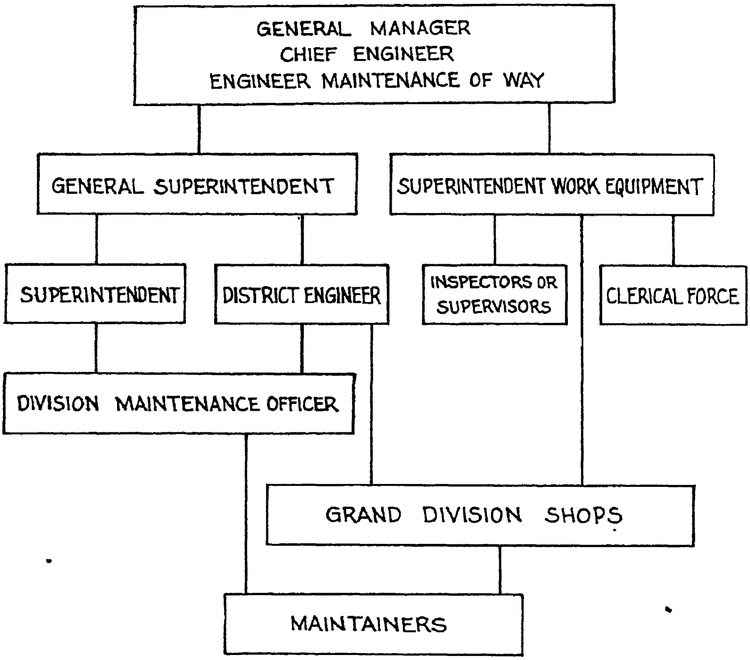
(4) Careful consideration should be given to the location of these shops to avoid excessive haul of equipment. Where plants already exist consideration should be given to the possibility of utilizing these facilities.

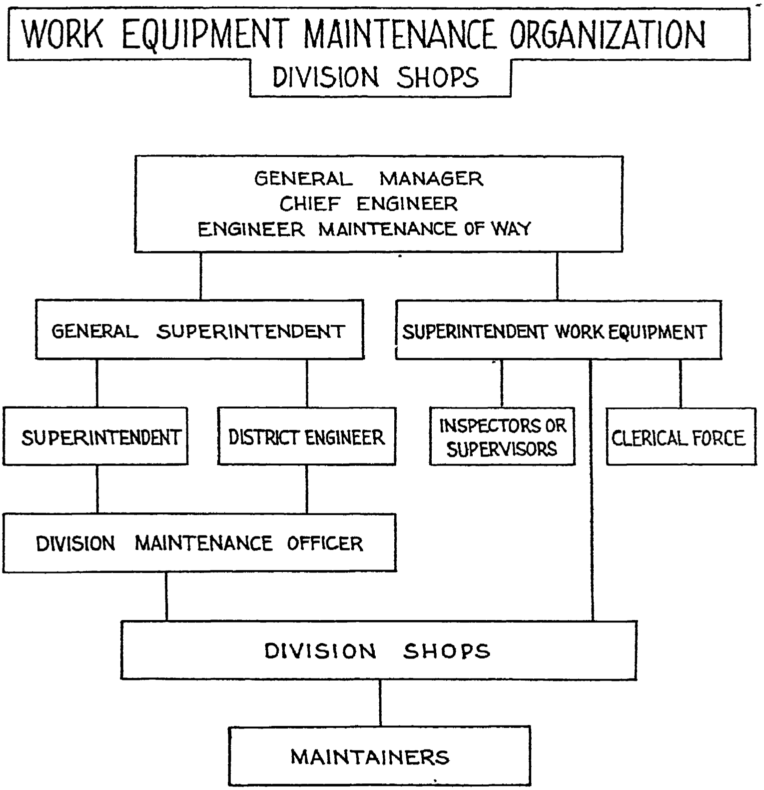
(5) These shops should be properly arranged for the work to be done and equipped with all necessary tools and machinery.

WORK EQUIPMENT MAINTENANCE ORGANIZATION
SYSTEM SHOPS



WORK EQUIPMENT MAINTENANCE ORGANIZATION
GRAND DIVISION SHOPS




WORK EQUIPMENT MAINTENANCE ORGANIZATION
DIVISION SHOPS
GENERAL MANAGER
CHIEF ENGINEER
ENGINEER MAINTENANCE OF WAY
GENERAL SUPERINTENDENT
SUPERINTENDENT WORK EQUIPMENT
SUPERINTENDENT
DISTRICT ENGINEER
INSPECTORS OR SUPERVISORS
CLERICAL FORCE
DIVISION MAINTENANCE OFFICER
DIVISION SHOPS
MAINTAINERS

REPORT OF COMMITTEE XXIII—SHOPS AND LOCOMOTIVE TERMINALS

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H. I. BENJAMIN,
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R. O. ROTE,
JOHN SCHOFIELD,
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L. K. SILLCOX,
H. L. SMITH,
H. W. WILLIAMS,
D. E. WOOZLEY,
G. I. WRIGHT,
M. J. T. ZEEMAN,
Committee.

† Died November 21, 1930.
‡ Died December 9, 1930.

To the American Railway Engineering Association:

Your Committee respectfully presents herewith report covering the following subjects:

(2) Locomotive washing platforms (Appendix A).

(3) General layouts and design of car shops, collaborating with appropriate committees of Division V—Mechanical, A.R.A. (Appendix B).

(4) Inspection pits (Appendix C).

Progress is also reported on the following subjects:

(1) Revision of Manual.

(5) General layouts and design of typical locomotive repair shops, collaborating with appropriate committees of Division V—Mechanical, A.R.A.

(6) Adapting the general layouts and design of car shops for inspecting and repairing multiple unit electric cars, collaborating with appropriate committees of Division V—Mechanical, A.R.A.

(7) Adapting the design of engine houses and the general layouts and design of typical locomotive repair shops for the inspection and repair of electric locomotives, collaborating with the appropriate committees of Division V—Mechanical, A.R.A.

Action Recommended

1. That the reports in Appendices B and C be accepted as information.
2. That the conclusions of the report in Appendix A be accepted for inclusion in the Manual.

Respectfully submitted,

THE COMMITTEE ON SHOPS AND LOCOMOTIVE TERMINALS,

L. P. KIMBALL, *Chairman.*

Bulletin 333, January, 1931.

Appendix A

(2) LOCOMOTIVE WASHING PLATFORMS

J. S. McBride, Chairman, Sub-Committee; C. M. Angel, H. E. Boardman, H. G. Dalton, A. G. Dorland, W. T. Krausch, L. H. Laffoley, B. M. Murdock, D. E. Woozley, M. J. T. Zeeman.

Questionnaire, relative to various features of washing platforms, was sent to twenty-six representative railroads and twenty-two replies were received. The replies of roads using washing platforms are tabulated in Exhibit A.

These replies show varying types of locomotive washing platforms. Some roads have constructed platforms entirely for the use of workmen; some, solely for drainage purposes; other roads use platforms to provide for both workmen and drainage, still others have made no provision for either.

Various materials have been used in the construction of platforms such as wood, bituminous coated crushed rock, brick and concrete. A number of roads using wood or bituminous coated crushed rock platforms have found them unsatisfactory. Other roads report the same kinds of platforms as satisfactory. Brick has been used only as platform outside of track. All roads using concrete have reported it as satisfactory. Only a small number of the roads reporting advise that they have adopted a standard, although others state that while not formally adopted as a standard platform they are using one platform exclusively.

From the plans received by the Committee, those roads using platforms for both drainage and as a footing for workmen have made them 9 ft. to 10.5 ft. wide outside of the center of track. The length of platform varies from the length of the longest locomotive washed to a length of 25 ft. greater than the length of the longest locomotive.

All roads have located their washing platforms between the cinder pit and turntable as it is not desirable to wash locomotives until after fires have been cleaned. Some roads prefer their inspection pit between washing platform and turntable.

Most roads have provided catch-basins to keep dirt washed from locomotives out of sewers. Some roads, in addition to catch-basins, use grease traps or oil skimmers to separate oil from sewage or to reclaim the oil.

A majority of platforms are lighted by floodlights, some by incandescent floodlights mounted on posts and a few platforms are not lighted.

The general practice is to house washing machines but a number of roads have the machines placed in the open. The machines that are housed are either located in an adjacent building or in a small frame or metal building, although one road has used stucco and concrete block buildings.

The method of storing the oil used in the washing is about equally divided between storage tanks and barrels or other small containers. The capacity of the storage tanks varies from 600 gallons to 15,000 gallons. A popular practice is to use tanks from old tank cars for storage purposes. Where storage tanks are used the oil is delivered from the tank direct to the washing machine. In an elevated tank the oil flows by gravity, while it must be pumped from underground tanks. Some roads pump oil from tank cars to elevated storage platforms, others make use of compressed air. In some cases it has been found desirable to pipe oil direct to washing machines from storage tanks in nearby oil houses.

Fig. 1, 2, 3, 4 and 5 are plans of several types of permanent locomotive washing platforms that have been installed.

The Committee recommends the following conclusions for printing in the Manual:

Conclusions

Locomotive Washing Platforms

Type

At important terminals, at least, where locomotives are washed, platforms should be provided for drainage purposes and for use of workmen. The platform should be of permanent construction, preferably concrete, with a top surface that can be readily cleaned. Any wooden ties or blocks used, to which to fasten the rail, should be treated timber. The surface of the platform should be at approximately the level of the track.

Size

The platform should be of sufficient size to provide for drainage and a footing for use of workmen. The width of the platform from the center of track should be a minimum of 9 ft. Where the washing is done on two adjacent tracks the platform should be continuous between tracks. The length of the platform should be sufficient to take care of the longest locomotive washed. In general, a platform about 5 ft. greater in length than the longest locomotive will be found satisfactory.

Location

The washing platform should be located between the cinder pit and the turntable, since the locomotive should not be washed until after the fires have been cleaned.

Drainage

The platforms should be properly sloped with a sufficient number of openings leading to sewers in order to remove the waste water from the platforms as soon as possible. Ample catch-basins should be provided to keep the dirt washed from the locomotives out of the sewer system.

Lighting

All platforms where locomotives are washed at night should be amply lighted. The method of lighting will depend somewhat upon local conditions. In some cases it can be taken care of by the general yard floodlighting system, in others it may be necessary to use overhead incandescent lamps mounted on posts at the sides of the platform and in other cases individual floodlights for the platform may be found desirable.

Housing Washing Machines

The washing machine should be housed either in an existing building near the washing platform or in a small building constructed for that purpose.

Oil Storage

At the larger terminals a storage tank should be provided for the storage of the oil and the oil should be piped direct from the storage tank to the washing machine. At the smaller terminals the oil may be kept in barrels or drums and handled by hand to the machines.

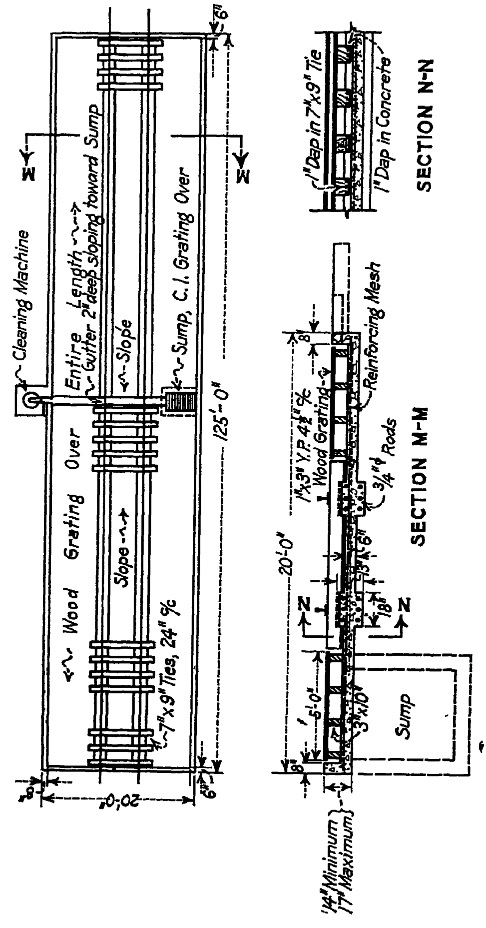
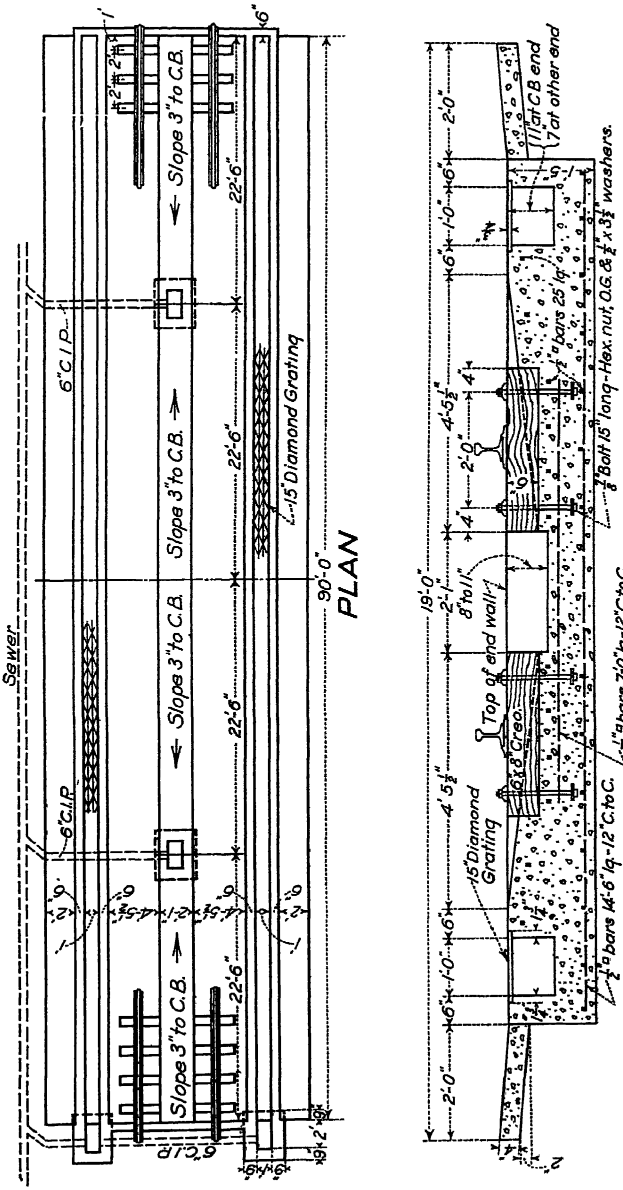


Fig. 1.
THE CHESAPEAKE AND OHIO RAILWAY COMPANY
LOCOMOTIVE WASHING PLATFORM



CROSS SECTION AT CENTER

Fig. 2.

C & E I RY

LOCOMOTIVE WASHING PLATFORM

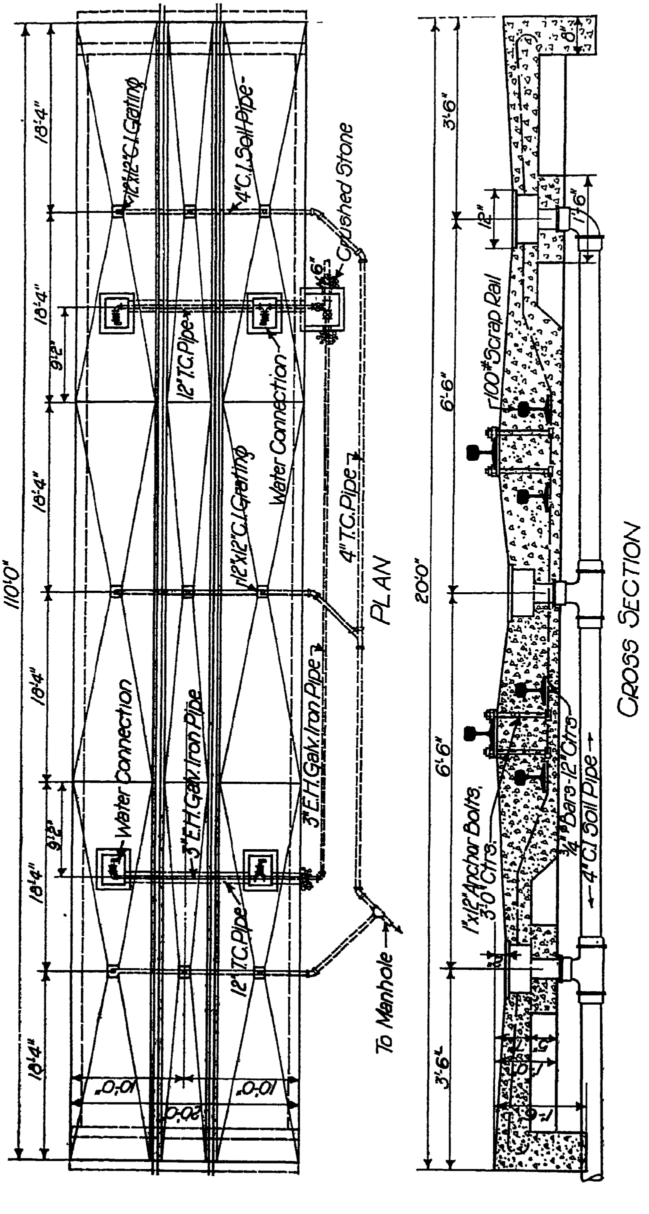


Fig. 3.
LOCOMOTIVE WASHING PLATFORM
NORFOLK & WESTERN RY. CO.

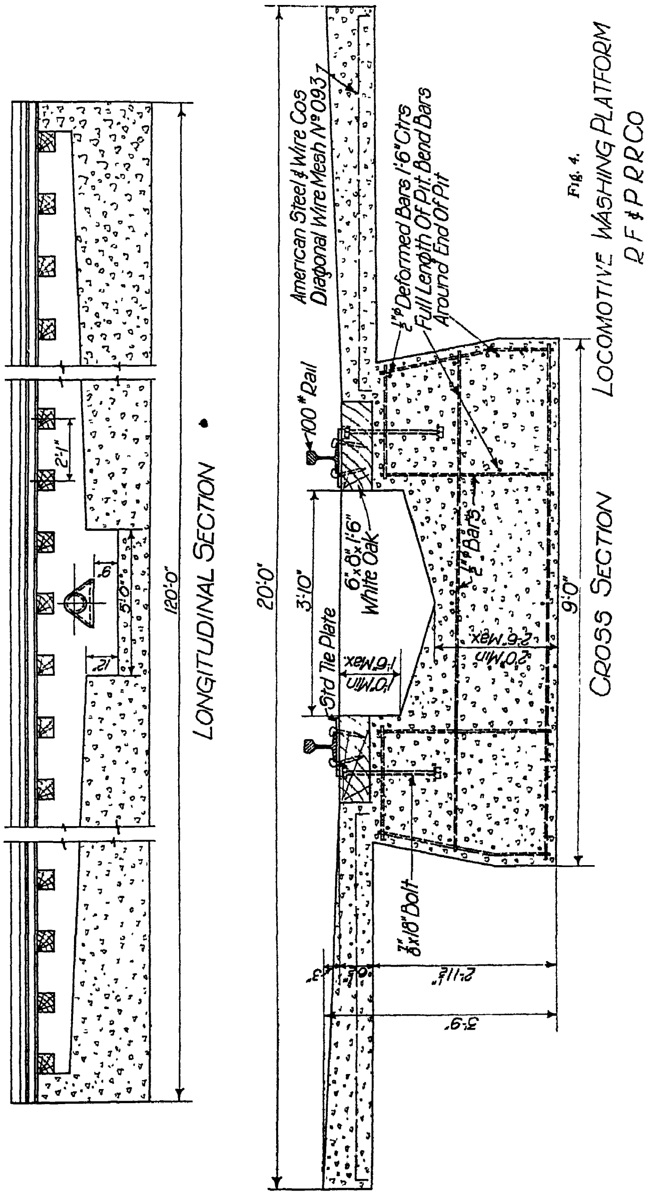


Fig. 4.

LOCOMOTIVE WASHING PLATFORM
P F & P R R Co

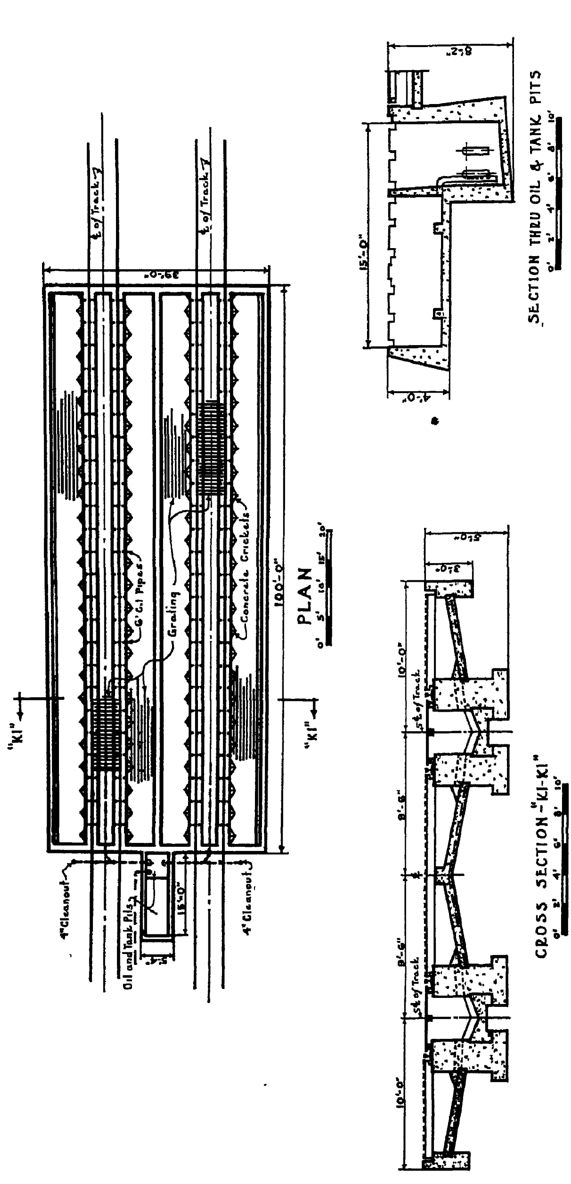


Fig. 5.

LOCOMOTIVE WASHING PLATFORM
THE BALTIMORE AND OHIO R.R.CO.

Appendix B

(3) GENERAL LAYOUTS AND DESIGN OF CAR SHOPS

J. M. Metcalf, Chairman, Sub-Committee; H. F. Bober, F. M. Davison, T. H. Gardner, C. E. Harris, J. S. McBride, John Schofield, L. K. Sillcox, H. W. Williams.

FREIGHT CAR SHOPS

This subject was discussed by this Committee in its reports to the 1921 and 1925 conventions of the Association. In 1921 the general requirements for car shop layouts were discussed and plans of a number of recently constructed shops were submitted with brief descriptions of outstanding characteristics. The 1925 report included further study of the principles which should govern shop design, and the recommendations with respect to clearances and other general features of layout and construction which now appear in the Manual. The Committee this year has endeavored to bring this matter down to date by consideration of the developments since the last report was made.

The Committee of the Mechanical Division, A.R.A., on Design of Shops and Engine Terminals, in its reports for 1926 and 1927 discussed freight car shop design, giving attention especially to the so-called progressive movement system for repairing cars, a development of comparatively recent years, the advantages of which for heavy repairs were brought out by this Committee in its 1925 report. The increasing use of this progressive system, and design of shops to accommodate it, have been among the outstanding developments of car shop construction in the past ten years.

A layout plan for use with the progressive system for heavy repairs to steel and composite cars, recommended by the Mechanical Division Committee, is shown as Fig. 1. This plan is for a so-called single end shop. It contemplates progressive movement through the shop on the central or stripping tracks, shifting by transfer table to the outgoing tracks, and return in the opposite direction, the various operations being performed at the different stages or "spots" during this progress. Such a plan requires less room for trackage than a double-end arrangement, and has the advantage that the return through the shop makes possible the repair of the parts taken from a car during the stripping and their later reapplication on the return trip with minimum labor and inconvenience in handling. Advocates of the double end shop, on the other hand, contend that a continuous movement through the shop in one direction permits a more convenient arrangement for progressive movements in the initial and finishing operations, such as stripping, sandblasting, painting and weighing, and has other advantages over the reverse movement. Many prefer it, and a number of recent shops have been constructed on that plan.

The following conclusions with regard to operation of the progressive system are drawn by the Mechanical Division Committee:

> 1. The progressive system has many advantages over the practice of taking cars into the shop as they come, regardless of service, class or kind of repairs needed.
>
> 2. The progressive system will reduce the cost of repairs as all material required for any operation can be handled in bulk to the point where the operation is performed.

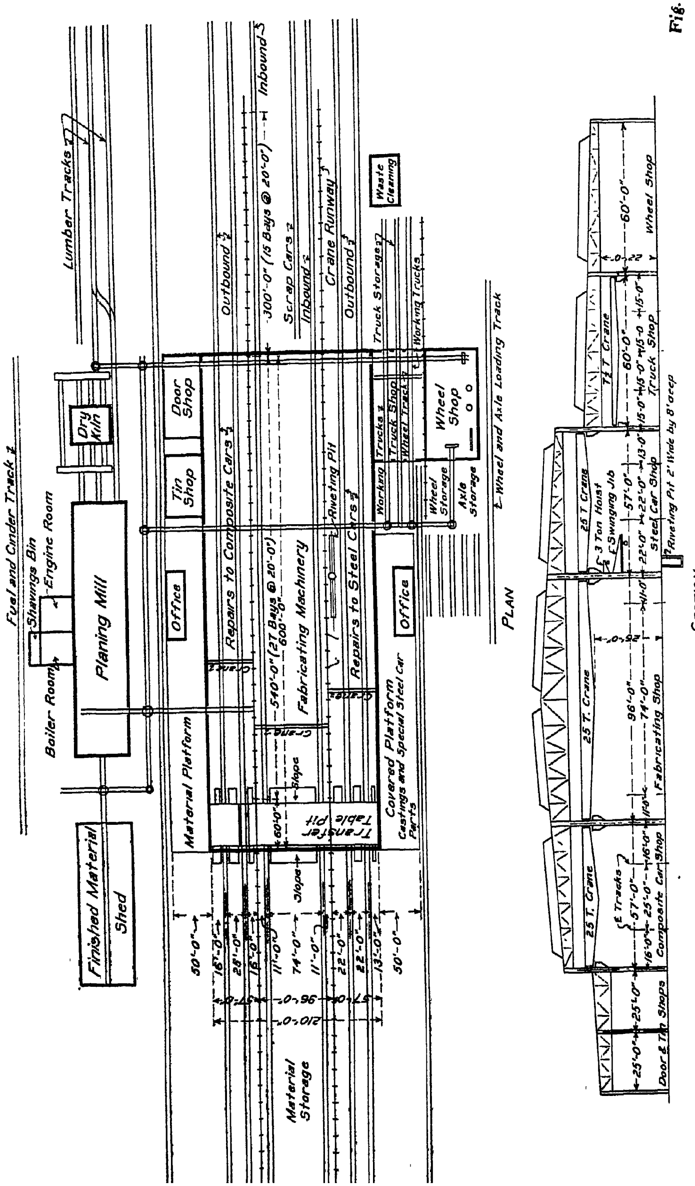


Fig. 1.

'L AND COMPOSITE CAR REPAIR SHOP — PROPOSED BY A-R-A COMMITTEE ON SHOPS AND ENGINE TERMINALS

3. The quality of the work performed will be improved due to the fact that each man will become a specialist on some particular operation.

4. The supervision required will be reduced and the output of any shop will be increased, other conditions being equal.

5. To operate the progressive system successfully necessitates shopping at one time a large number of cars of the same service and requiring the same general class of repairs.

On basis of information as to practice in a number of such shops, the Mechanical Division Committee has outlined a program for progressive movement of cars including nine positions for all steel cars, seven for composite or wood cars, as follows:

1. Stripping—often performed outside or in a separate stripping shed.
2. Repairing trucks. In some shops trucks are removed and sent to a truck repair shop, car moving through shop on "dolly" trucks, and repaired trucks being placed under it as it leaves the shop.
3. Repairing frames.
4. Applying steel siding and end sheets, fitting and bolting in place, and reaming holes.
5. Riveting.

   (NOTE: With composite or wood cars, positions 4 and 5 are often omitted, or work done at position 3.)
6. Applying floors, siding and all other parts below roof.
7. Applying roofs, running boards and doors.
8. Applying air brakes and safety appliances.
9. Painting and stencilling.

At one large shop recently constructed, primarily for work on steel coal cars, the separation of the various operations is carried further and eighteen positions and operations are designated. Preparatory to designing this shop, an elaborate study was made of the time and organization necessary for each operation, to produce the desired output of completed cars. In this way the number of employees and total time required for each operation and the car standing space to be provided for the corresponding position were determined. Such a study is essential to rational designing of a shop for progressive operation, as upon it depend the track space to be provided and the convenient arrangement of machinery and other facilities to produce the desired output.

Increased general use of overhead cranes has been a feature of design in recent shops, particularly those planned for repair of all-steel and composite cars. An interesting development is the extension of crane runways through an end of the shop building and extending under a transverse crane as shown in photograph, Fig. 2, of Russell, Kentucky, shop of the Chesapeake & Ohio.

Another comparatively novel feature has been the elimination from some layouts of all material tracks. In such cases a concrete or other hard surfaced pavement is provided throughout the shop and movements of material are made altogether by truck and trailer and by crane.

A wide variation in design and layout, to fit local conditions, class of cars to be handled and character of work to be done, is indicated by following descriptions of recent shops.

PENNSYLVANIA RAILROAD.—Shops for heavy repair to steel cars, built on same general design at Enola (Harrisburg), Pa., and at Pitcairn, Pa., designed for progressive system, bad-order cars to enter at one end, and leave at the other fully repaired and ready for paint shop. Capacity approximately 33 cars per day.

Rivet cutting shed, 200 ft. by 36 ft. 8½ inches, covering two tracks on 16 ft. centers, and with lean-to 55 ft. by 15 ft. for housing electrical equipment.

Main car shop building 100 ft. by 620 ft. served by three 15-ton traveling cranes, of full width of building and operating throughout its length and 140 feet over outside extension. Three incoming tracks, two of them those which serve the rivet cutting shed, extend into the tear-down end of the shop, on 16 ft. centers. At this end there are also 3-50 ft. truck storage tracks and a truck repair track 110 ft. long. In the other end of the shop are three set up tracks 325 ft. long, on 20 ft. and 34 ft. centers, and one short scrap track. Office, storeroom, lavatory and lunch room facilities are housed in brick and concrete building adjoining and connected directly to shop building.

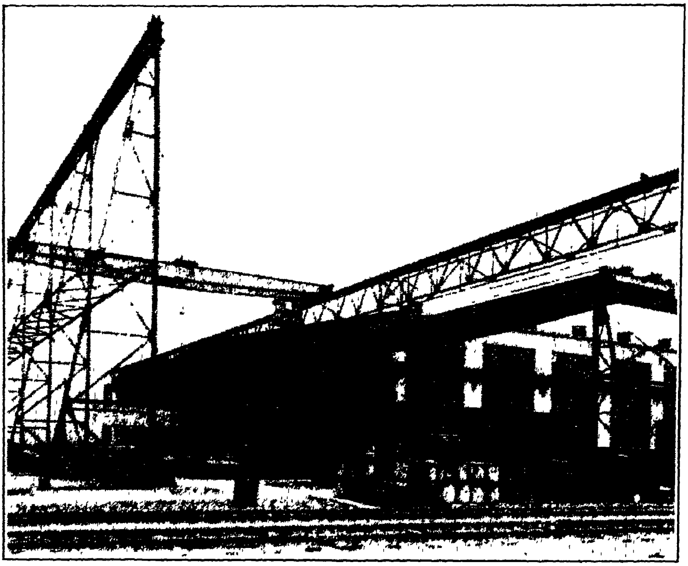


FIG. 2—OUTSIDE CRANES AT RUSSELL, KY., CAR SHOPS ON THE CHESAPEAKE & OHIO RAILWAY

DENVER & RIO GRANDE WESTERN.—Similarly designed shop layout at Denver and Salt Lake City include separate buildings for wood car and steel car repairs, on opposite sides of a transfer table.

Steel car shop, 65 ft. by 242 ft. is served by two tracks, along the sides of the building, running through the shop and a shorter stub track for bringing in material between them at one end. Two 15-ton overhead traveling cranes span the building.

Wood car shop 65 ft. by 240 ft. has three tracks lengthwise through the building, the center one of which is for truck repair work only.

SOUTHERN RAILWAY.—Car repair shop, part of complete mechanical layout at Birmingham, 107 ft. by 598 ft., three bays 38 ft., 40 ft. 10 inches and 26 ft. with two tracks in each of the first two and one track in the third bay. Two 20-ton cranes serve the second bay, and two 15-ton cranes the third. Machine shop addition 51 ft. by 158 ft. adjoins the center section. Tracks are connected at both ends.

ELGIN, JOLIET & EASTERN.—Steel car repair shop at Joliet, Ill. Seven bays, each 42 ft. 10 in. wide, two 325 ft. long, one 450 ft. long, and four 500 ft. long. In the first three bays are five standard gage tracks connected through at each end to yard leads, with narrow gage tracks in alternate intervals. In the last three bays are six standard gage stub end tracks, similarly served by narrow gage material tracks. Six-ton traveling cranes operate through the length of each bay.

READING.—Freight car repair shop at Reading, Pa., 235 ft. by 880 ft. Main unit 235 ft. wide served by 8 tracks on 25 ft. centers, with lean-to 100 ft. wide for blacksmith shop, machine shop, air brake repair room, lumber storage, bench room and wood mill. Concrete floor throughout the building, level with tops of rails and entirely enclosing tracks except rail heads and flangeways. Exterior pairs of tracks are served by 50-ton overhead cranes, others by 25-ton cranes.

FLORIDA EAST COAST.—Freight car shop at St. Augustine, Fla. Designed for progressive movement of cars from inspection to re-weighing. After inspection and marking, cars pass through a four track stripping shed 192 ft. long, and thence into the main shop. The first spot in the shop is in a transverse bay, housing the four tracks which extend through from the stripping shed, and served by a 50-ton, 4 hook gap crane. Trucks are removed and while they are being worked on repairs of sills, frames and draft gear are completed. Re-assembled on its trucks, on one of two parallel tracks, the car moves through the remainder of the shop which is of longitudinal design. Decking, sheathing, lining, roofing, doors, safety appliances, and air brakes are here applied in five spot positions. The car then passes on into the paint shop, an extension of the same building served by the same two tracks, and thence to scales for weighing ready to return to service.

CANADIAN PACIFIC.—Freight car repair shop at Winnipeg, constructed 1928. Extension, 305 ft. by 328 ft. of an existing shop. Eight tracks on 22 and 24 ft. centers, all connected at both ends. All floors mastic on concrete, with concrete runway outside on three sides of building, connecting with general scheme of runways covering all shops and stores. Designed particularly with view to handling material with electric trucks. 15-ton electric traveling cranes over two of the four track bays, and 5-ton crane over 80 ft. machine, mill and blacksmith bay.

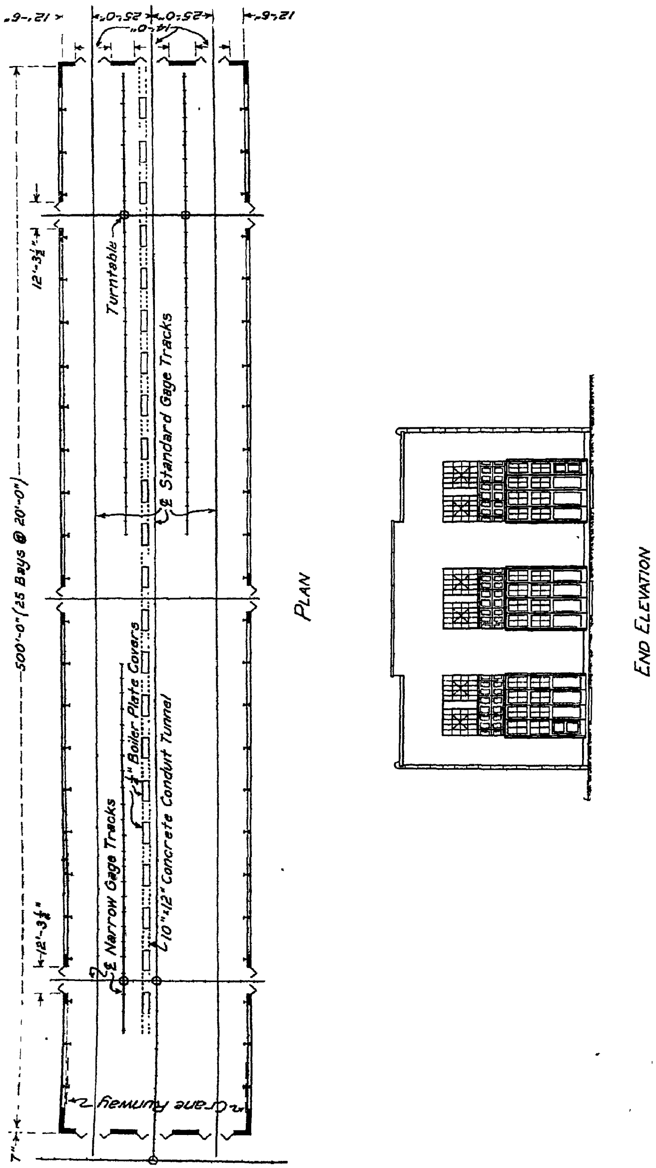
CHICAGO, ROCK ISLAND & PACIFIC.—Steel car repair shops at Chicago, Ill. (Fig. 3) and El Reno, Okla. Chicago shop 75 ft. by 500 ft., constructed 1928; El Reno of same general design, but 400 ft. long, constructed 1929. Three tracks on 25 ft. centers, with narrow gage material tracks between them. 15-ton cranes spanning entire width of building, and with runway extending 200 ft. outside the building at the Chicago shop.

CHICAGO, MILWAUKEE, ST. PAUL & PACIFIC.—Freight car repair shop at Milwaukee, Wis. (Fig. 4) constructed 1929, 196 ft. by 1,000 ft. One bay 72.5 ft. wide and two each 60.5 ft. wide, each served by 15-ton crane. Three tracks on 24 ft. centers in first bay, two on 40 ft. centers in center bay, and two on 28 ft. centers in third bay. Most of the stripping to be done outside, but provision for two cars inside for stripping during inclement weather. 300 feet of opposite end of shop partitioned off for paint spraying and drying, and number of tracks increased to ten, on 14 and 16 ft. centers, in this section. Entire space between tracks floored with concrete so that it is accessible to trucks.

CHESAPEAKE & OHIO.—Steel coal car shop at Russell, Ky., planned for an output of 40 cars per day.

Rivet burning shop 80 ft. by 200 ft., housing three tracks, two for standing cars being stripped, the third for loading scrap, which is removed and loaded by overhead crane equipped with lifting magnet.

Main erecting shop, two bays each 80 feet by 750 feet, with lean-to 80 ft. by 75 ft., for blacksmith and fitting up shop, and 90 ft. by 100 ft. for truck shop. Each of the two main bays is served by two 15-ton overhead



Steel Car Repair Shop - Chicago, Rock Island & Pacific Railway

Fig. 3.

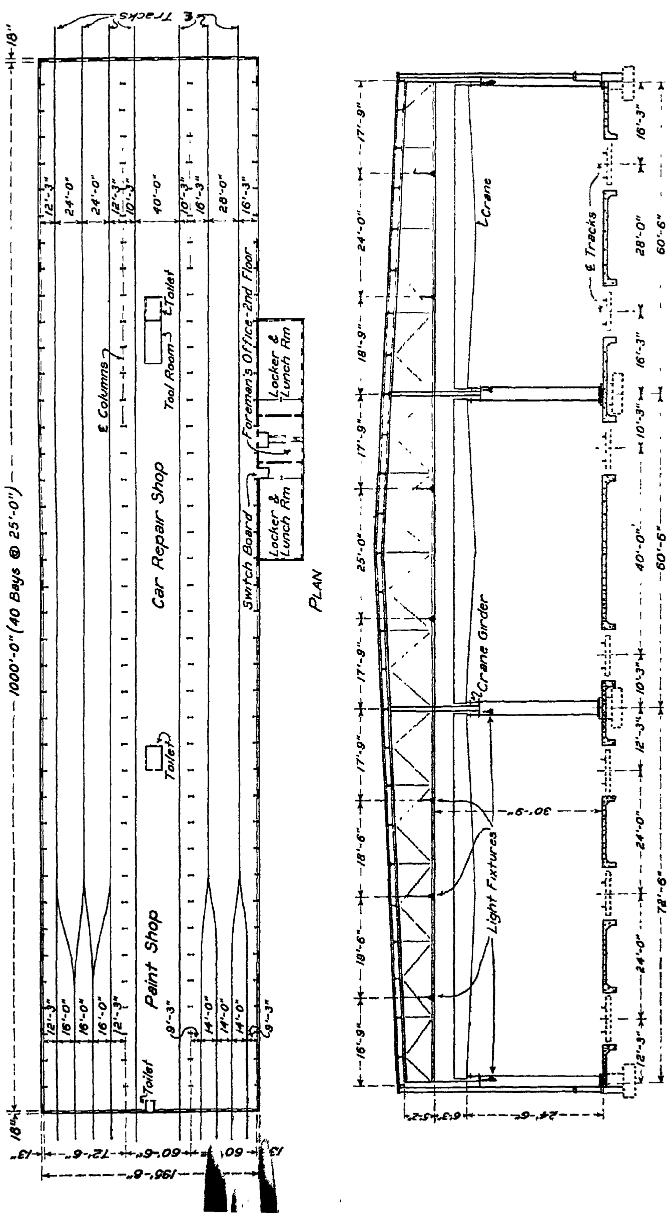


Fig. 4.

FREIGHT CAR REPAIR SHOP - CHICAGO, MILWAUKEE, ST. PAUL & PACIFIC R R

electric traveling cranes and each contains three through tracks. The cranes extend outside the building at one end under a 15-ton transverse crane.

Paint shop 90 feet by 675 feet, contains 5 tracks, and provision also for air brake and pipe work, to be applied while paint is drying.

CANADIAN NATIONAL.—Plans for new shop being developed. It is proposed to place both freight and passenger car shops under one roof, adjoining on opposite sides a central bay which serves both, and includes all auxilliary shops, such as wood mill, blacksmith, air brake and electrical shops. Freight car shop to be 865 ft. by 192 ft., with eight longitudinal tracks, served in groups of two and three by 30-ton and 20-ton cranes. Shop designed for progressive movement, with five "spots," three cars to the "spot" on each track.

The conclusions adopted in 1925 and now appearing in the Manual, cover well the general requirements of design, and no changes or additions are recommended at this time.

FIRE SAFEGUARDS IN PAINT SHOPS

Fire hazards, always present in connection with storage and application of paints, varnishes, etc., are materially increased by the spraying process, now in general use in railroad car painting shops, and are especially acute where pyroxylin lacquers and finishes are used. In design and operation of paint shops the safeguarding against these hazards should be given careful attention.

For information as to best practice in such design and operation to provide protection against fire, attention is directed to the recommendations of the Railway Fire Protection Association, as printed in the handbook of that Association, and to publications of the National Fire Protection Association, issued in pamphlet form, on "The Spray Application of Flammable Finishing Materials," reprinted from the Association's Quarterly of April, 1928; "Regulations for Paint Spraying and Spray Booths" and "Pyroxylin Finishes, Their Use, and Suggestions for Safeguarding the Attendant Hazard."

Appendix C

(4) INSPECTION PITS

H. C. Lorenz, Chairman, Sub-Committee; F. C. Baluss, H. I. Benjamin, C. T. Dike, A. S. Kent, L H. Laffoley, W. S. McFetridge, E. S. Pennebaker, R. O. Rote, M. J. T. Zeeman.

Location

Outside locomotive inspection pits are generally located near the turntable or just beyond the coal dock and are installed to save engine time at the enginehouse. Inspection is made and report sent to the foreman, who is then able to assemble material and be ready to proceed with repairs upon arrival of engine at the enginehouse. They are also installed at points where inspection and light repairs are made at the pit (there being no enginehouse).

General Practice

A study of the practice of seventeen representative railroads of this country reveals that only seven of them used outside inspection pits, one does preliminary inspection where conveyor type cinder pit is used, and the remainder do the inspection at the enginehouse.

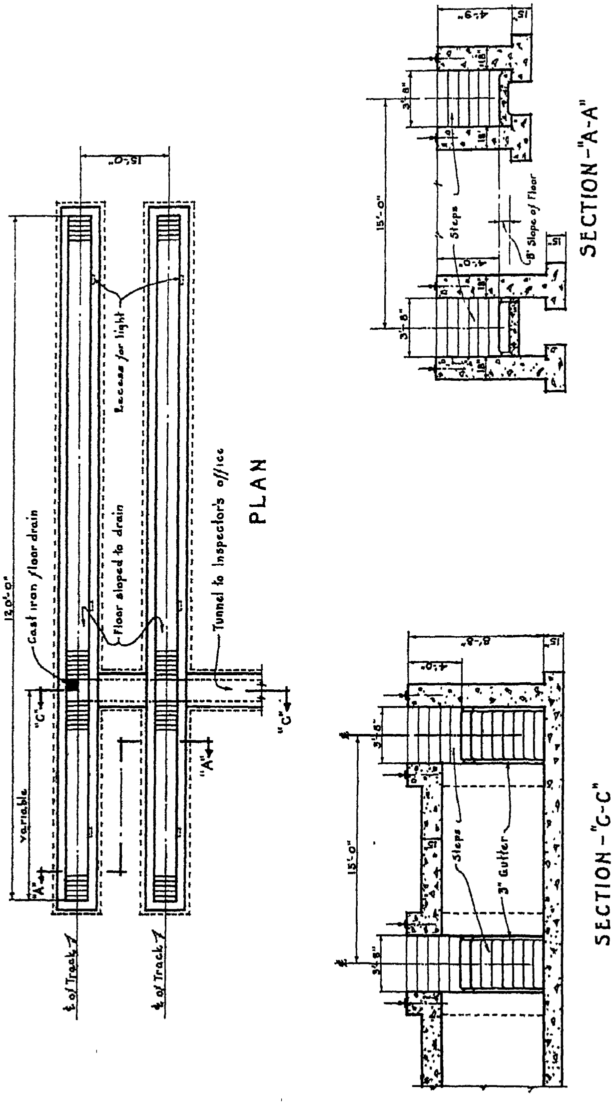
General Design and Operation

Locomotive inspection pits should preferably be constructed of reinforced concrete. They may vary in length from 40 feet to 120 feet, depending upon the length of the longest locomotive to be inspected. Pit depths varying from 2½ feet to 4½ feet, with provision for drainage, afford satisfactory operation. Stairways should be constructed in the pit either at the ends or near the center for convenience of entering and leaving the pit. In some of the larger pits now in service, tunnels connect the pit and the inspector's office located nearby. It is general practice to light pits by electricity, either by placing the lights in recesses constructed in the wall, or by service outlets into which a portable electric light may be plugged. Some roads provide protection from the weather by constructing sheds over the pits, but of the roads studied in compiling this report, most of them do not provide this shelter. Where inspection pits are used in connection with other enginehouse facilities it is desirable to provide direct communication between the pit and the enginehouse by installation of either telephone or a pneumatic tube system. Fig. 1 will illustrate the general construction of a modern inspection pit, connected by tunnel to the inspection office and which may be connected by pneumatic tube to the enginehouse.

Recommendations

It is the recommendation of the Committee that inspection pits should be of reinforced concrete construction, well drained, electrically lighted in such manner as to avoid too much glare and too strong shadows, and that the pit be located beyond the coal dock, so as to permit sufficient time to elapse between inspection and arrival of the locomotive at the enginehouse, in order that necessary material may be assembled for repairs to be proceeded

with upon arrival of the locomotive in the house. The Committee is not disposed to make recommendations concerning size of pit, shelter or means of communication with points outside the pit, as these are questions which must be determined by local conditions.



TYPICAL INSPECTION PIT

FIG. 1.

REPORT OF COMMITTEE XI—RECORDS AND ACCOUNTS

C. C. HAIRE, *Chairman;*
E. Y. ALLEN,
ANTON ANDERSON,
R. G. BOWIE,
R. R. L. BULLARD,
E. S. BUTLER,
E. B. CRANE,
W. F. CUMMINGS,
T. F. DARDEN,
W. J. FOSTER,
C. J. GEYER,
J. H. HANDE,
C. R. HARTE,
W. E. HEIMERDINGER,
ALFRED HOLMEAD,
W. W. JAMES,
W. R. KETTENRING,
C. A. KNOWLES,
HENRY LEHN,
W. T. MEAD,
E. W. METCALF,
W. S. MCFETRIDGE,
B. A. BERTENSHAW, *Vice-Chairman;*
J. T. POWERS,
H. L. RESTALL,
H. L. RIPLEY,
E. F. SALISBURY,
HANS SCHANTL,
F. C. SHAROOD,
CHARLES SILLIMAN,
D. W. SMITH,
F. X. SOETE,
JAMES STEPHENSON,
D. C. TEAL,
T. W. TU,
Y. UEMURA,
J. T. VITT,
G. R. WALSH,
J. W. WEBSTER,
H. R. WESTCOTT,
A. P. WEYMOUTH,
K. G. WILLIAMS,
LOUIS WOLF,
W. H. WOODBURY,

Committee.

To the American Railway Engineering Association:

Your Committee respectfully presents herewith report covering the following subjects:

(1) Revision of Manual.—The Committee reports progress and is making survey of material in Manual to determine needed revisions, as well as to develop information that should be added in order to have a comprehensive text book in the field of records and accounts.

(2) Changes or revisions in I.C.C. Classification of Accounts.—The Interstate Commerce Commission has not announced a new or revised Classification of Accounts during the year so the Committee has nothing to report.

(3) Methods and forms for gathering the data for keeping up-to-date the valuation and other records of the property of railways with respect to:

(a) Changes made necessary by government regulations.
(b) Simplicity and practicability of use. (Appendix A).

(4) Methods and forms for handling the Interstate Commerce Commission's requirements under Order 15100—Depreciation Charges of Steam Railway Companies (Appendix B).

(5) Methods for avoiding duplication of effort and for simplifying and co-ordinating work under the requirements of the Interstate Commerce Commission with respect to accounting, valuation and depreciation (Appendix C).

(6) Statistical requirements of the accounting, operating or other departments with respect to maintenance of way and structures, collaborating with appropriate committees.—The Committee reports progress in its investigation of the subject, but due to apparent overlap of assignment with other committees, it has been deemed inadvisable to proceed further until there is worked out more definite collaboration.

Bulletin 333, January, 1931.

(7) Forms used by railway water service departments, collaborating with Committee XIII—Water Service and Sanitation (Appendix D).

(8) Accounting for industry tracks in its relation to ownership and contract provisions, collaborating with Committee XX—Uniform General Contract Forms (Appendix E).

(9) Methods and forms:

(a) For maintaining a record of railway, highway and private grade crossings, collaborating with Committee IX—Grade Crossings.

(b) For making annual reports of grade crossings added or eliminated, collaborating with Committee IX—Grade Crossings.

The Committee has prepared a tentative report covering the second subject (b) of its assignment, but is withholding the report until Committee IX—Grade Crossings, has completed such investigation as is needed before collaboration.

(10) Methods and forms for maintaining a record of changes in jointly owned interlocking plants, with respect to ownership and contract provisions, collaborating with Committee X—Signals and Interlocking (Appendix F).

(11) Use of mechanical devices for accounting (Appendix G).

(12) Bibliography on subjects pertaining to Records and Accounts, appearing in current periodicals (Appendix H).

(13) Bridge inspection report forms, collaborating with Committees VII—Wooden Bridges and Trestles, VIII—Masonry, XII—Rules and Organization, and XV—Iron and Steel Structures (Appendix I).

(14) Methods used in recapture proceedings (Appendix J).

Action Recommended

(1) That the reports on subjects 1, 2, 4, 5, 12 and 14 be received as information and the subjects continued.

(2) That the reports on subjects 3, 6, 7, 9, 10 and 13 be received as progress reports and the subjects continued.

(3) That the reports on subjects 8 and 11 be received as information and the subjects discontinued.

Respectfully submitted,

THE COMMITTEE ON RECORDS AND ACCOUNTS,

C. C. HAIRE, *Chairman.*

Appendix A

(3) METHODS AND FORMS FOR GATHERING THE DATA FOR KEEPING UP-TO-DATE THE VALUATION AND OTHER RECORDS OF THE PROPERTY OF RAILWAYS WITH RESPECT TO:

(a) Changes made necessary by government regulations.

(b) Simplicity and practicability of use.

B. A. Bertenshaw, Chairman, Sub-Committee; E. Y. Allen, R. G. Bowie, Alfred Holmead, W. W. James, W. R. Kettenring, W. T. Mead, H. L. Restall, H. L. Ripley, E. F. Salisbury, James Stephenson, J. W. Webster, Louis Wolf, W. H. Woodbury.

DEFINITIONS OF TERMS

ADDITIONS.—Additional facilities, such as additional equipment, tracks, buildings, bridges and other structures, and additions to such facilities.

ACCOUNTING ADJUSTMENT.—A restating of an amount in the accounts of a railway by changing the amount or transferring to another account or accounts.

ACCOUNTING REPORT.—A statement compiled and published by the Interstate Commerce Commission, showing the financial history of a railway and a re-statement of its accounts as of a stated date of valuation.

AUTHORITY FOR EXPENDITURE.—An authorization made in writing by an executive officer of the railway management authorizing an expenditure to create, purchase, change or retire certain physical property, setting forth in detail the description, reasons, estimated costs and financial effect of the project.

BETTERMENT.—Improvement of an existing facility through the substitution of superior parts for inferior parts retired.

BUDGET.—A statement giving recommended projects and their estimated cost to be undertaken for a definite period or a forecast of income or expenditures for a given period.

CARRIER (adj.)—Applicable to physical property of a railway and other assets used in or held for transportation service.

CARRIER (noun)—A corporate company, owner of physical property and other assets used in or held for transportation service.

CHART.—A delineation or statement in graphical form.

COST.—The outlay incurred in acquiring, creating, operating or maintaining a property, including the money value of the services rendered and other considerations involved.

ENGINEERING REPORT.—A statement compiled and published by the Interstate Commerce Commission, showing the physical property of a railway (except "Land"), classified according to ownership and use by units, unit prices and totals, purporting to give the cost of Reproduction New and Reproduction Less Depreciation of a railway at a given date of valuation.

EQUIPMENT.—Rolling stock, floating equipment and highway vehicles devoted to common carrier's service.

EQUIPMENT COMPLETION REPORT.—A record prescribed by Valuation Order No. 3, Second Revised Issue, showing for equipment detailed information with respect to additional units placed in service, withdrawals therefrom, additions and betterments thereto, and the costs chargeable and creditable to the accounts of the carrier as a result thereof.

FACILITY.—A portion of the property capable of rendering a specific service.

FEDERAL VALUATION.—The survey and reports following a mandate of Congress designated as Section 19a of the Interstate Commerce Act, requiring the Commission to investigate, ascertain and report the value of all the property owned or used by every common carrier subject to the provisions of the Interstate Commerce Act.

FINAL VALUATION.—The value for rate-making purposes found by the Interstate Commerce Commission in pursuance of its work under Section 19a of the Interstate Commerce Act.

FIXED PROPERTY.—Property of immovable nature or incapable of a change in location without reconstruction, either in whole or in part; property which may not be used except in a fixed location.

GROSS CHARGE.—A sum on the debit side, representing the entire amount or total of the charges resulting from any transactions before credits are deducted.

GROSS CREDIT.—A sum representing the entire amount or total of credits resulting from any transactions before debits are deducted.

GROSS COST.—The total outlay incurred in any transaction, including the money value of services rendered and other considerations involved before credits are deducted.

INDEX NUMBER.—The ratio between the price of a unit of property as of a given date and the price of the same property as of a fixed date.

INCOME ACCOUNT.—The account showing the net amount of money received, or the deficit for services rendered by a railway, including returns from investments. Operating Revenues and other sources of income are credit accounts and Operating Expenses, Taxes and other similar costs are debit accounts.

INVENTORY (noun)—Records showing material, supplies and other assets of a railway at end of any given period.

INVENTORY (verb)—The act of counting and recording material, supplies or other property of a railway.

INVESTMENT ACCOUNT.—See Investment in Road and Equipment.

INVESTMENT IN ROAD AND EQUIPMENT.—The account in transportation accounting to which the cost of all carrier property and changes in carrier property is debited or credited.

JOINT FACILITY.—Railway property which two or more carriers either jointly own, maintain or operate by formal agreement.

LAND REPORT.—A statement compiled and published by the Interstate Commerce Commission, showing a detail of the land and non-carrier improvements owned by a railway and purporting to show the value as of a stated date, indicating the property used for transportation purposes and otherwise.

LEDGER VALUE.—The value at which the property is carried in the Property Investment Account of the carrier.

NET CHARGE.—A sum on the debit side, representing the entire amount or total of the charges resulting from any transactions after credits are deducted.

NET CREDIT.—A sum representing the entire amount or total of the credits resulting from any transactions after debits are deducted.

NON-CARRIER.—Applicable to physical property and other assets of a railway neither used nor held for transportation service.

OPERATING EXPENSES.—The expenditures of a railway for furnishing transportation service, including expenditures for maintaining the carrier property used in service.

OPERATING EXPENSES—MAINTENANCE OF WAY AND STRUCTURES.—The expenditures of a railway for maintenance, repairs and depreciation of property devoted to operations except equipment and shop and power plant machinery.

OPERATING EXPENSES—MAINTENANCE OF EQUIPMENT.—The expenditures of a railway for maintenance, repairs and depreciation of equipment and shop and power plant machinery.

OPERATING EXPENSES—TRANSPORTATION FOR INVESTMENT.—Cr.—The amount representing the cost to a railway for transporting men, materials and equipment for construction work, which is credited to this account in Operating Expenses and charged to the Investment Account.

OPERATING EXPENSES—WATER LINE.—The expenditures of a railway for transporting persons and freight by water lines, including water terminal expenses.

OPERATING EXPENSES—TRANSPORTATION RAIL LINE.—The expenditures for train service by a railway for transporting persons and freight including station, yard and terminal service.
OPERATING EXPENSES—GENERAL.—The expenditures of a railway for general administration, accounting, law, real estate, claim, relief, pensions and expense not directly assignable to other phases of railway operating expenses.
OPERATING EXPENSES—TRAFFIC.—The expenditures of a railway for advertising, soliciting and securing traffic, including the publication and distribution of tariffs.
OPERATING EXPENSES—MISCELLANEOUS OPERATIONS.—The expenditures of a railway for dining cars, hotels, restaurants, grain elevators, stock yards and other miscellaneous operations.
ORIGINAL COST TO DATE.—The cost of original construction plus all costs incurred thereafter for improvements, less credits for property retired.
PAYROLL (noun)—A list of persons or employees showing amount earned for services performed.
PAYROLL (adj.)—Applicable to expenditures in railway accounts resulting from the cost of labor.
PRICE TREND.—The general course or direction of price changes over a given period of time, related to a fixed base. They may be expressed by index numbers or diagram.
PRIMARY ACCOUNT.—A mandatory, designated subdivision of a general account in railway accounting required by the Interstate Commerce Commission.
PROFILE.—A longitudinal section through a work or section of country to show the elevations and depressions.
PROFIT AND LOSS.—A subdivision of railway accounts in which to record transactions which result in gains and losses from all operations.
PROJECT.—A scheme or plan for creating or changing physical property.
PROPERTY CHANGE.—Any change in the physical property.
PROPERTY REPLACED.—An accounting unit of property which is taken out of service and replaced with another.
REPLACEMENT.—Act of replacing some previously existing facility with property to serve a like purpose.
RETIREMENT.—Act of removing property which for any reason is taken out of service for which it was created or installed; fixed property moved from one valuation section to another.
RETIREMENT ENTRY.—An amount credited to the Investment Account as the ledger value for a unit of property taken out of transportation service.
ROADWAY COMPLETION REPORT.—A report required by Interstate Commerce Commission, Valuation Order No. 3, Second Revised Issue, to show for each project the detailed changes in physical property by units and costs, as included in the Road Accounts.
SALVAGE.—The appraised value of material recovered from property retired or from property after use as a construction aid.
TENTATIVE VALUATION.—A tentative report by the Interstate Commerce Commission to Congress on each common carrier, made pursuant to Section 19a of the Interstate Commerce Act, setting forth the Commission's tentative findings of fact, as specified by law, and its findings of the value for rate-making purposes of property owned or used by such common carrier for common carrier purposes, and certain other information prescribed by law on its non-carrier property, served upon each common carrier owning or using any part of such common carrier property, and upon certain other parties specified by law, as a basis for receiving testimony and hearing argument from all interested parties concerning a final report by the Commission to Congress of its findings of such facts and values for such common carrier.
UNIT COST.—The cost of any selected unit of property.
VALUATION ORDER NO. 3.—An Order of the Interstate Commerce Commission to enable it to comply with the provisions of paragraph (f), Section 19a of the Interstate Commerce Act. It prescribes a uniform system for recording and reporting changes in the physical property of every common carrier subject to the act to regulate commerce.

A

VOUCHER.—A record of payment used in the railway industry that indicates in detail and by proof the entire history of the transaction.

VALUATION RECORDS.—Records of a nature to show the money value of the component parts of railroad property and evidence of methods and data used in determining such costs and value.

The above definitions of terms, with the exception of "Index Number" and "Price Trend," have been previously presented to the Association and are recommended for inclusion in the Manual.

(a)-1. Methods and Forms for Bringing Land Valuations to a Later Date

On June 12, 1928, the Interstate Commerce Commission approved the "Outline of Plan for Bringing Land Valuations to December 31, 1927, and Such Other Date or Dates as may be Fixed by the Director of Valuation."

This "Outline of Plan" is set out under ten Sections, as follows:

1. Determination and Elimination of Properties which will not require reappraisal.
2. Maps.
3. Carrier's co-operation in the accumulation of sales data.
4. Joint verification of sales data.
5. Agreement as to Zoning.
6. Independent fixing of units of value.
7. Agreements as to area, classification, etc.
8. Establishment of local headquarters.
9. Other valuation orders.
10. Co-ordination with recapture work.

(1) The plan sets out that there are parts of properties which are of relatively small importance compared with the total value of the lands used, and that there are also properties or parts of property in which there has been no substantial change in value since the original value was placed on these properties. The railroads are accordingly asked to indicate those parts of their properties in which there has been no substantial change in value and therefore complete reappraisals not justified.

Some railroads extend through a more or less congested section of the country in such a way that a large portion of their total land "Value" is included within cities or towns. For such a railroad the "value" of rural lands is of little importance in the total valuation, while other railroads may have a very large part of their land "value" made up of rural property. In any event, a careful study should be made of the entire system to identify the locations of the most valuable property. This study will indicate the percentages of land "value" in rural sections and in the most important cities and towns. It will also furnish important data for determining which sections are most important to reappraise and which ones may be eliminated.

(2) If the railroads have complied with the I.C.C. orders relating to maps which provide that they shall keep available reproductions of the maps prepared for the original valuation work and keep them current by posting changes in property subsequent to the date of valuation, it becomes an easy matter to furnish the maps necessary for assembling the data for reappraisal.

(3), (4), (5) and (6) It is the Bureau of Valuation's plan in bringing land valuations to a later date to follow the same general procedure as was used in the original valuations. The principal exception is that the Carriers'

and Bureau's appraisers are to agree as to certain facts concerning sales of adjacent land prior to the establishment of Zone units of "value." Practically the same amount of work as was previously required is still necessary and entails the detailed investigation and analysis of data for each individual Zone.

The first step in the appraisal work consists of making an examination of the County Records for sales and assessments. The sales information

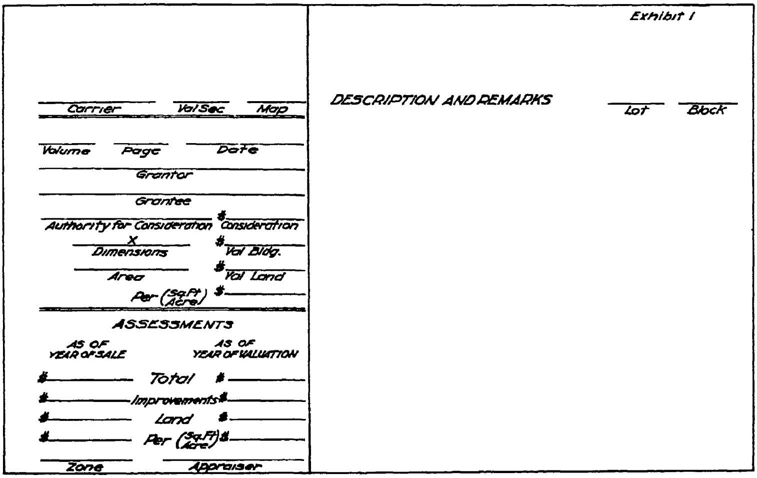


Exhibit 1

Carrier — Val Sec — Map

Volume — Page — Date

Grantor

Grantee

Authority for Consideration — $ Consideration

X Dimensions — $ Val Bldg.

Area — $ Val Land

Per (Sq Ft / Acre) $

ASSESSMENTS

AS OF YEAR OF SALE — AS OF YEAR OF VALUATION

$ Total $

$ Improvements $

$ Land $

$ Per (Sq Ft / Acre) $

Zone — Appraiser

DESCRIPTION AND REMARKS — Lot — Block

secured from these records is entered in pencil on a memorandum Form, Exhibit 1, size 5½ inches by 8½ inches. This size is convenient for pads and for handling in the field. The information is then transcribed with typewriter on a Supplemental Sales Sheet, Exhibit 2, size 8½ inches by 11 inches, one sheet of each of these exhibits being made for each sale.

All of the sales data within a Zone is next listed on a Form "Summary of Sales Data," Exhibit 3, size 8½ inches by 11 inches. As supporting information to the sales a Form, Exhibit 4, size 8½ inches by 11 inches, lists the "Assessed Value of Adjoining and Adjacent Land." These two Forms collect in convenient shape the information to be used by the appraiser in arriving at the proper unit value to be assigned to the property within the Zone.

In order to obtain additional information on sales over that secured from the County Records, letters may be sent to the Grantor and Grantee in questionnaire form, which will develop whether or not the recorded consideration was the actual consideration and other facts or conditions that may have had an influence on the sales price. Many appraisers prefer to obtain this information by making personal calls.

After having studied the data and arrived at a proper unit value, this unit value is next recorded on a Form, Exhibit 5, and the major portion of this form is given over to a detailed explanation of how the unit value was derived. Any other supporting data which cannot be recorded on the fore-

going forms, such as opinions of "value" given by local men, may be recorded here. If there is more than one class of land in a Zone there will be a corresponding number of unit values by classes and a similar number of explanations.

Exhibit 2

NORTH AND SOUTH R.R.

SUPPLEMENTAL SALES SHEET

VAL. SEC. NO. ________

ZONE NO. ________

Zone ________ Map ________ Sale No. ________

City: ________ County: ________ State: ________

Date: ________ Book: ________ Page: ________ Consideration: ________

Grantor: ________

Grantee: ________

Assessment as of year of sale		Sale Analysis	
Land:	$ ________	Land:	$ ________
Improvements:	$ ________	Improvements:	$ ________

Dimensions: ________ x ________ Area: ________ Sale Unit: $ ________

Authority for Consideration: ________

Authority for Value of Improvements: ________

Date of Verification: ________

Remarks: ________

____

Land Appraiser

Exhibit 6 is a summary by classes of land of all property in a Zone, by years. For the sake of brevity the numbers corresponding to the classes of land have been used for columnar headings which are as follows:

Class 1—Lands owned and used by the owner for its purposes as a common carrier.

Class 2-1—Lands used by the carrier for its purposes as such but owned or leased by other common carriers.

Exhibit 3

NORTH AND SOUTH R.R.

STATE ______________ VAL. SEC. __________

COUNTY ______________ ZONE NO. __________

MUNICIPALITY __________ MAP NO. __________

SUMMARY OF SALES DATA

GRANTOR GRANTEE	Year	Area	Consideration	Value of Impvts.	Value of Land	Unit Val. of Land	Sale No.

Exhibit 4

NORTH AND SOUTH R.R.

STATE ______________ VAL. SEC. __________

COUNTY ______________ ZONE NO. __________

MUNICIPALITY __________ MAP NO. __________

ASSESSED VALUE OF ADJOINING AND ADJACENT LAND

DESCRIPTION	Year	Area	ASSESSED VALUE			Estab'd Ratio	Resulting Unit Value	Sale No.
			Land	Impvts.	Land Unit			

Exhibit 5

NORTH AND SOUTH R.R

STATE ______________ VAL. SEC. ______________

COUNTY ______________ ZONE NO. ______________

MUNICIPALITY ______________ MAP NO. ______________

LAND APPRAISAL

______________ Appraiser

Boundaries of Zone

From ______________ To ______________ ______________ Date

VALUATION AS OF ______________ 19____ UNIT VALUE PER ZONE ______________ Per Sq. Ft. / Per Acre

Exhibit 6

NORTH AND SOUTH R.R.

ZONE RECORD SHEET

VAL. SEC ______________

ZONE NO ______________

MAP. NO ______________

Description ______________

	CLASS	1	2-1	2-2	3-1	3-2
1920	Area					
	Unit					
	Amount					
1921	Area					
	Unit					
	Amount					
1922	Area					
	Unit					
	Amount					
1923	Area					
	Unit					
	Amount					
1924	Area					
	Unit					
	Amount					
1925	Area					
	Unit					
	Amount					
1926	Area					
	Unit					
	Amount					
1927	Area					
	Unit					
	Amount					

Areas Computed

Date ______________ Appraiser ______________

Computer ______________ Date ______________

Exhibit 7

NORTH AND SOUTH R.R.

SUMMARY SHEET

VAL. SEC. ____________

DATE ____________

CARRIER LAND

CLASS		1	2-1	2-2	3-1	3-2
1920	Area					
	Amount					
1921	Area					
	Amount					
1922	Area					
	Amount					
1923	Area					
	Amount					
1924	Area					
	Amount					
1925	Area					
	Amount					
1926	Area					
	Amount					
1927	Area					
	Amount					

NON CARRIER LAND AND IMPROVEMENTS

		Class 4			
		Land	Improvements	Land	Improvements
1920	Area				
	Amount				
1921	Area				
	Amount				
1922	Area				
	Amount				
1923	Area				
	Amount				
1924	Area				
	Amount				
1925	Area				
	Amount				
1926	Area				
	Amount				
1927	Area				
	Amount				

Remarks:

Size 11x17
Exhibit 8

NORTH AND SOUTH R.R.
Reporting Carrier

ROADWAY COMPLETION REPORT

GENERAL ACCOUNTS I ROAD AND III GENERAL EXPENDITURES

Progressive - Final Report No. ________

Sheet No. ______ of ______
A.F.E. No. ________
Estimate No. ________
State ________
Val Sec. ________
Ch. Sta or M.P. ________
Line ________
Operating Div ________
Date Report Made ________

Owner ________
Lessee ________
Operating Co. ________
Cost borne by ________
Description of Project ________

Work done by ________
Work begun ________
Project Completed ________
Date put in / Retired from } Service ________

PROPERTY ADDED				DESCRIPTION		PROPERTY RETIRED			
						From VO3		From Eng. Rept.	
No. of Units	Cost	Unit	Acct No		Cost as Acct'd. for	No. of Units	Cost	No. of Units	Cost

Subscribed and sworn to before me this ________ day of ________ 19____

________ (Signature)

________ (Title)

I, ________ (Name) ________ (Title), of the above named Company, do swear that the foregoing report of property changes which were made under my supervision is true to the best of my knowledge and belief.

________ (Signature)

________ (Title)

A.F.E. No. ________ Completion Report No. ________

Class 2-2—Lands used by the carrier for its purposes as such, but owned by parties other than common carrier.
Class 3-1—Lands owned by carrier but used exclusively by another carrier or carriers for common carrier purposes.
Class 3-2—Lands leased by carrier, but used exclusively by another carrier or other carriers for common carrier purposes.
Class 4—Non-carrier lands owned, including value of improvements owned by carrier.

Exhibit 6 is designed for handling "Carrier" property only, but if desired, a similar form for handling "Non-Carrier" property may be made or an additional column placed on this form with heading "4" if it is not desirable to have an additional form.

Exhibit 7 is a valuation section summary of all Zones by years of all classes of land. This is merely a summation on one sheet of all Exhibit 6 sheets in a valuation section.

(7) This section provides for the continuation of the present plan for disposing of, by conference or correspondence, questions arising as to computations of area, classification of land, etc.

(8) Provides for the establishment of local headquarters and, for the sake of uniformity and efficiency, the retention of the same appraisers until all the land in their territory has been appraised.

(9) This section states that subschedules have been provided under supplements to Valuation Order No. 3, showing details of the acquisition of land parcels, similar to those supplied by returns to Valuation Order No. 7. It also contains another interesting feature as follows: "Some modification of the requirements of Order No. 15 may be necessary in order to classify lands leased to private parties in accordance with recent instructions within the Bureau. Consideration should, however, be given to pending proposals as to the revision of the Commission's accounting requirements in accordance with which rents received by Carriers for incidental private or semi-private use of their property will be classified as operating revenues, presumably with approval of a carrier classification for many items of property now set up as non-carrier. Such a change in the prescribed accounting procedure would apparently affect the whole basis of the instructions now regarded as governing and would, in great measure at least, obviate the need of returns to Order No. 15."

(10) This section provides that "the land section will, concurrently with the work of bringing valuations to date, make the necessary appraisals for prospective recapture cases."

It is stated above that the Bureau's plan in bringing land valuations to a later date is to follow the same general procedure as was used in the original valuations. The principal feature of this procedure is that the railroad land is appraised by comparison with so-called similar adjacent land. While forms such as those described above have been designed to accumulate the facts in convenient form, the judgment of the appraiser must be relied upon to produce accurate results.

The railroads, while not agreeing that the Bureau's method is correct, have for the sake of co-operation with the Bureau, generally adopted the Bureau's method. This assumes that most adjacent land is similar in general character to that contained in the right-of-way which is divided into zones, the zone limits being determined by differences in "value" of the adjacent lands.

Size 11x17
Exhibit 9

NORTH AND SOUTH R.R.
Reporting Carrier

ROADWAY COMPLETION REPORT

Continuation Sheet

Progressive-Final Report No.____

Sheet No._____ of_____
A.F.E. No.________
Estimate No.________

PROPERTY ADDED				DESCRIPTION	PROPERTY RETIRED				
					Cost as Acct'd for	From V.O.3		From Eng. Rept	
No. of Units	Cost	Unit	Acct. No.			No. of Units	Cost	No. of Units	Cost

A.F.E. No______ Completion Report No.______

Conclusions

The appraisal of land cannot be reduced to an exact formula and it is impossible, therefore, to obtain results with mathematical precision. The "personal equation" is always in evidence and instances where the results obtained by the Bureau and the railroads are in exact agreement are few. For this reason co-operation as outlined by the I.C.C. is desirable in order to eliminate as far as possible all questions as to fact. It is also evident that the railroads should entrust this work only to men of mature judgment and experience who will be able to correctly interpret the facts and make proper application of them in arriving at unit "values."

(a)-2. Forms

Section No. 6 of Supplement No. 5 to Valuation Order No. 3 requires in the compilation of B.V. Form 588, retirements to be subdivided so as to show separately property retired that was included in the basic valuation reports and property retired that has been installed since date of inventory.

The Roadway Completion Report, Form 1117, shown on page 724 of the Manual, was designed prior to such requirement and therefore no provision was made for the above separation of property retired.

This separation of retirements should now be shown on the Roadway Completion Report so as to be carried through the Record of Property Changes and on B.V. Form 588. The Committee has accordingly designed a form for Roadway Completion Report—Exhibit 8, and Continuation Sheet—Exhibit 9, on which provisions have been made to show this additional information.

The Committee also presents two forms for Roadway Machines and Shop Machinery which have been revised so as to conveniently furnish information needed to comply with Supplement No. 5 to Valuation Order No. 3, Second Revised Issue, and other information useful to the railroad.

Exhibit 10

NORTH AND SOUTH R R
ROADWAY MACHINE RECORD
KIND: ____________

Sheet ____________

Carrier's No.	Manufacturers				Weight	Size or Capacity	A.F.E. No.	Date in Service	Original Cost	Retired	
	Name	Model No.	Car No.	Engine No.						Date	A.F.E. No.

Exhibit 10 is a record of Roadway Machines, 8½ inches by 11 inches. These machines are to be recorded according to kind, such as Motor Cars, Concrete Mixers, etc. Exhibit 11 is a Record of Shop Machinery, 8½ inches by 11 inches in size. There will be only one machine recorded on a sheet. The sheets may be kept in machine number order or by location and kinds of machines, as desired.

These forms have not been sufficiently tested out to warrant their adoption, and are presented as information.

Exhibit II

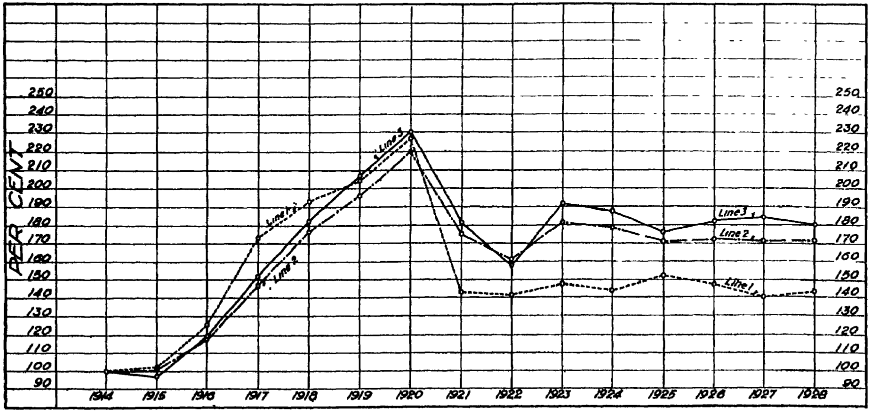
NORTH AND SOUTH R.R.
RECORD OF SHOP MACHINERY

Sheet No.______
Val. Sec.______

Name of Machine______ Carrier's No.______
Maker______ R.P.M. C'tr'shaft______
Maker's No.______ Type______ Countershaft Pulley______
Rated Size______ Kind of Drive______
Bought From______ Motor No.______ Size______
A.F.E. No.______ Req'n. No.______ Date______ Gen'l. Plan No.______
F.O.B. Point______ Fd'n. Plan No.______
Receiving Point______ Transfer to______
Installed at______ A.F.E. No.______ Date______
Foundation-Kind & Size______ Transfer to______
Shipping Wt.-Lbs.______ A.F.E. No.______ Date______
Net Wt.-Lbs.______
F.O.B. Cost______ Remarks:______
Foreign Freight______
Company Freight______
Foundation Cost______
Installation Cost______
Total Cost in Place______

NORTH AND SOUTH RAILROAD

Exhibit 12



PRICE TRENDS

Line 1 ------- Wholesale Prices of All Commodities from the Bureau of Labor Statistics.

Line 2 —·— Indices Developed by the Bureau of Valuation, I.C.C., for use in Territory East of the Mississippi River and North of the Ohio and Potomac Rivers except New England— all Accounts except "Land"

Line 3 —— Trends of Railroad Construction Costs—Presidents' Conference Committee—Pittsburgh—Chicago District Cost Data Committee — all Accounts except "Land"

These graphs are shown for illustrative purposes only

(b)-1. Use of Price Trends

It frequently becomes necessary to make an appraisal or valuation of a railroad property, or a portion of a railroad, as of a given date. Subsequent to the World War there has been a wide fluctuation in prices, some items having a wider range than others. In order to make an accurate valuation, therefore, it is necessary to develop unit prices as of the date under consideration for each item of property to be valued. If, however, such a degree of accuracy is not necessary an approximate result may be obtained by the use of Price Trends or Index Numbers.

Quite a number of sets of Price Indices or Index Numbers have been developed which show the ratio of costs or prices as of a given date to the costs or prices as of a fixed date used as a base. Of recent years the year 1914 is most often used as the fixed date and prices of that year taken as the base.

Exhibit No. 12, which is presented for illustrative purposes only, shows graphically three sets of Price Indices, or Index Numbers, for the years 1914 to 1928 inclusive, using the year 1914 as a base or 100 per cent. Line 1 shows the variation in wholesale prices of "All Commodities" based on data in Bulletins of the Bureau of Labor Statistics and includes about 550 commodities. Line 2 represents railroad construction costs (except land) as developed by the Bureau of Valuation, I.C.C., for territory east of the Mississippi River and north of the Ohio and Potomac Rivers, except New England. Line 3 represents railroad construction costs (except land) as developed by the Cost Data Committee of the Pittsburgh-Chicago District—Presidents' Conference Committee.

To make practical use of "Price Trends" it is, of course, necessary to first either develop a set of Index Numbers from data at hand or to select Index Numbers compiled by others that best fit or apply to price changes on the property under consideration. It then remains only to find the cost of the property as of the fixed date and multiply this cost by the Index Number as of the date desired. For sake of illustration, let us assume that it is desired to estimate the cost of constructing a section of railroad in 1926, and for this purpose we will select Line 3 on the Chart. We will find the cost of this section as of the year 1914 and multiply it by the Index Number for the year 1926—1.82. Similarly, if the cost is known for any year and the approximate cost is wanted for some other year, it may be found by applying the ratios of the Index Numbers for the two years under consideration. For example, the cost of a property is known as of the year 1919 and it is desired to know what it would cost to construct the same property in 1925. The Index Number for 1919 is 2.07 and for 1925 it is 1.76. The cost in 1925 would bear the same ratio to the cost in 1919 as 1.76 bears to 2.07, or 85 per cent.

The railroads and various organizations have developed Index Numbers for the different investment accounts such as Account 3—Grading, Account 6—Bridges, Trestles and Culverts, Account 51—Steam Locomotives, etc. Index Numbers have also been developed for the principal items in an Account, as for example, for common excavation, loose rock and solid rock in Account 3—Grading, and for plain concrete, reinforced concrete, timber and structural steel in Account 6—Bridges, Trestles and Culverts.

The Index Number for an Account is composite, developed by applying the Index Number for the various items that make up the Account against the ratio or per cent that each item bears to the total. Similarly, the Index Number for an entire railroad is developed by applying the Index Number of the individual Accounts against the ratio or per cent that each Account bears to the total. Whether the Index Number for the individual item, for a group of similar items, for the Account, or for the entire property is to be used in making an estimate, depends upon the degree of approximation that will be satisfactory.

(b)-2. Simplified Method of Reporting Account No. 10—Other Track Material

The amount of work involved in recording and reporting changes in each item in Account 10—Other Track Material—is out of all proportion to the importance of the Account, since the total of the Account is a very small percentage of the total cost of Accounts 1 and 3 to 77 inclusive. The Committee has therefore made a study in an effort to find some short method of handling the items in this Account that will produce sufficiently accurate results.

The following methods have been suggested and given study:

1. Method recommended in memorandum submitted by Presidents' Conference Committee, Circular Communication No. 1504-Ch., dated September 28, 1928.
2. Typing of Track by classes and weights of material.
3. Use of single unit price for retirements—weighted average price per cwt. of all new material.
4. Use of two unit prices for retirements—one, a weighted average price per cwt., for all new frog and switch material, and a second unit price for all other new material in the Account.

Sufficient tests have not been made to enable the drawing of any conclusions and this subject will be continued for study next year.

Appendix B

(4) METHODS AND FORMS FOR HANDLING THE INTERSTATE COMMERCE COMMISSION'S REQUIREMENTS UNDER ORDER NO. 15100—DEPRECIATION CHARGES OF STEAM RAILWAY COMPANIES

W. R. Kettenring, Chairman, Sub-Committee; B. A. Bertenshaw, E. S. Butler, T. F. Darden, C. J. Geyer, C. R. Harte, W. W. James, Henry Lehn, W. T. Mead, J. T. Powers, F. C. Sharood, G. R. Walsh, and Louis Wolf.

The Committee's report of last year recorded the issuance of the Proposed Report by Interstate Commerce Commissioner Eastman, dated August 15, 1929, and contained a comparison of that report with the Order of November 2, 1926.

In accordance with the directions contained in the letter transmitting the Proposed Report, hearings were held in November, 1929, and counsel for the Presidents' Conference Committee filed statement of exceptions and brief. This was followed by oral argument on December 5 and 6, 1929.

While it is understood that this subject is still under consideration by the Commission, no modification of the Order of November 2, 1926, has been issued to October 31, 1930.

No detailed work has been done by the Committee pending action by the Commission.

Appendix C

(5) METHODS OF AVOIDING DUPLICATION OF EFFORT AND FOR SIMPLIFYING AND CO-ORDINATING WORK UNDER THE REQUIREMENTS OF THE INTERSTATE COMMERCE COMMISSION WITH RESPECT TO ACCOUNTING, VALUATION AND DEPRECIATION

F. C. Sharood, Chairman, Sub-Committee; É. Y. Allen, T. F. Darden, C. C. Haire, W. R. Kettenring, Alfred Holmead, C. A. Knowles, H. L. Restall, H. L. Ripley, E. F. Salisbury, J. H. Hande, Chas. Silliman, James Stephenson.

This assignment is a new one. The accounting and depreciation orders of the Commission are now being revised, their precise form is not known and therefore this report is submitted as subject to change when the final orders of the Commission are promulgated.

The requirements of the Interstate Commerce Commission dealt with in this report are those which affect the work of carriers in accounting for and reporting expenditures for physical property installed and cost of physical property retired.

The Bureaus of the Interstate Commerce Commission which have to do with these matters are:

Bureau of Accounts
Bureau of Accounts—Depreciation Section
Bureau of Valuation—Accounting Section
Bureau of Finance
Bureau of Statistics

The Bureau of Accounts formulates the rules governing the accounting for this class of expenditures which have been issued in the form of an order of the Commission styled Classification of Investment in Road and Equipment. The rules in this classification are the bases for determining the accounting for all transactions involving the acquisition or retirement of physical property. The accounting in the classification now in effect, is upon two bases—one, the retired and replaced basis and the other the betterment basis. The retired and replaced basis is one by which the whole cost of the new property installed is charged to the Investment Account, and the whole cost of property retired is credited thereto. The betterment basis is one where only the excess cost of replacing material installed over the cost of replacing in kind the material retired, is charged to the Investment Account. The remainder of the cost of a betterment project is chargeable to Operating Expenses. The Bureau of Accounts does not require carriers to make reports to it, nor does not prescribe a system of records, but confines its work to making periodical checks of the records of the several carriers and to issuing interpretations of the rules in the classification.

The Depreciation Section of the Bureau of Accounts has issued a tentative plan for accruing depreciation on certain classes of property the cost of which is carried in the accounts prescribed in the Classification of Investment in Road and Equipment. That plan does not recognize the betterment basis of accounting but requires that all accounts be stated on the retired and replaced basis. The Section does not in its plan prescribe any system of records but does require that the lives of units be recorded as well as their cost.

The Bureau of Valuation has issued an order known as Valuation Order No. 3, with sundry supplements thereto the administration of which is now in the Accounting Section of that Bureau. The order which deals with units as well as costs, prescribes a list of units and a system of records to be kept and reports to be rendered to the Commission. The costs to be reported under this order are those recorded under the rules prescribed in the Investment in Road and Equipment Classification, except that the order requires that consequential items accounted for on the betterment basis, be restated to the retired and replaced basis.

The Bureau of Finance has issued an order covering the form of reports to be rendered in connection with all applications for permission to issue securities or for certificates of necessity and convenience in connection with the construction of new lines, the acquisition of existing lines or the abandonment of existing lines. The reports required by the order of the Bureau of Finance are to be based upon the costs recorded under the rules prescribed in the Classification issued by the Bureau of Accounts but in a form different from those prescribed in Order No. 3 of the Bureau of Valuation. For example: The Form B.V. 588 required by Supplement 5 to Order No. 3, is a report upon which is stated the units and their cost installed and the units and their cost retired in connection with projects completed during the year for which the report is rendered. This report is made by valuation sections for land and roadway property, and by accounts for equipment. This report ignores individual authorities for expenditure in most instances. The report required by the Bureau of Finance must be made by individual authorities for expenditure without reference to Valuation Sections, must show the expenditure for each authority and for completed projects there must be furnished a copy of the completion report, and for uncompleted projects a copy of the authority for expenditure must be furnished. This difference in form of reports requires the keeping of separate sets of collection sheets in order to meet the requirements of two Bureaus of the same regulatory body.

The Bureau of Statistics does not issue any instructions or orders with respect to the keeping of accounts or records, but does issue a form of report in which the results obtained by the application of rules prescribed in the classification of the Bureau of Accounts are set forth. In Schedules 211, 211L and 211E, the accounting results are reported. The form of this report is different from the reports required by the other Bureaus dealing with the same subject in that the Bureau of Statistics requires a statement of the year's work by primary accounts divided between construction of new lines and additions and betterments to existing lines, the latter being divided further as between gross cost of new work incurred during the reporting year, gross cost of property retired during the current year and corrections made during the current year which affect either additions or retirements in previous years. This requirement injects a third set of records for recording increases and decreases

in the Investment account. The Bureau of Statistics also requires the reporting in Schedules 411 to 421, inclusive, 510 to 516, inclusive, and 491, certain physical facts in connection with the operations of the carrier during the year. This requirement necessitates the keeping of records of certain units separate and distinct from those required by Order No. 3 of the Bureau of Valuation.

Thus we have four bureaus of the Commission and a section of one of those Bureaus issuing orders or requiring reports on the one subject Investment in Road and Equipment, and no effective means devised as yet on the part of any one of the five to co-ordinate their varying requirements. Some efforts are being made, however, to co-ordinate the Classification of Investment in Road and Equipment, the rules in the Depreciation Order and Order No. 3 requirements, by eliminating the betterment basis of accounting, but the results of those efforts have not as yet been available to carriers.

Co-ordination of the varying requirements of the several Bureaus of the Commission will, without doubt, have the effect of lessening the cost and simplifying the keeping of records by carriers. There has been a unanimous opinion expressed by all carrier representatives, that economy and simplicity in this work is desirable but there has not been any unity of views as to how this simplification should be accomplished. Your Sub-Committee has offered preliminary suggestions to valuation and accounting representatives of various carriers, but few constructive suggestions have been received. The officials of carriers charged with the keeping of valuation have one viewpoint while the representatives of the accounting departments have another viewpoint, in most instances these viewpoints are at great variance.

Before any effective action can be taken in presenting this subject to the Commission, it will be necessary for carriers to secure harmony in their own ranks. This result may possibly be obtained by concerted action by a committee composed of representatives of the Presidents' Conference Committee, the Railway Accounting Officers Association, and the American Railway Engineering Association. At present the responsibility for conducting valuation work is lodged with the Presidents' Conference Committee who are also under direction of the Executives' Association handling the matter of depreciation, while the accounting work is being handled by the Railway Accounting Officers Association. The American Railway Engineering Association includes in its membership a large group of men who are attempting to make practical application of the varying and sometimes conflicting requirements of the Commission and who are responsible for the cost of the work. Several attempts have been made in the past to bring the thought of these three organizations along the same general lines, but as yet nothing has been accomplished which resulted in the elimination of work or the lessening of costs.

It is the recommendation of this Committee that this subject be continued and given the earnest consideration of the membership of this Association. Constructive suggestions by any of the members of the Association who are interested, are invited and if sent to the Chairman of this Committee, will be studied during the coming year.

Appendix D

(7) FORMS USED BY RAILWAY WATER SERVICE DEPARTMENTS, COLLABORATING WITH COMMITTEE XIII—WATER SERVICE AND SANITATION

D. C. Teal, Chairman, Sub-Committee; R. R. L. Bullard, E. W. Metcalf, H. L. Restall, E. F. Salisbury, Hans Schantl, W. H. Heimerdinger, D. W. Smith, J. T. Vitt, T. W. Tu, Y. Uemura.

Four forms dealing with water station records are now shown in the 1929 Manual, as follows: Form 1301 on page 955—Pumper's Daily Report, Form 1302 on page 956—Statement of Cost of Pumping Water, Form 1303 on page 957—Water Station Record, and Form 1304 on page 958—Geological Record of Deep Wells.

These forms were adopted by the Association in 1909. Since that time many changes have been made in the organization of Railway Water Service departments and in the methods of pumping water.

In the pursuance of the assignment copies of present-day water service forms have been procured from most of the larger carriers of the country.

Analization and study of the various forms have resulted in the following general classification of forms now being used by Railway Water Service Organizations:

(1) Monthly and Yearly Report of Cost of Producing and Treating Water.
(2) Pumpers and Treating Plant Operators Daily Report.
(3) Water Station Record.
(4) Geological Record of Deep Wells.

Comparing the above list with the ones now included in the Manual it is obvious that Class 1, "Monthly and Yearly Report of Cost of Producing and Treating Water" can be considered an up-to-date version of Manual Form No. 1302, that Class 2, "Pumpers and Treating Plant Operators Daily Report" is for the same purpose as Manual Form No. 1301, that Class 3, "Water Station Equipment Record," covers the same ground as Manual Form No. 1303, and that Class 4, "Geological Record of Deep Wells" is the same as Manual Form No. 1304.

The Committee has selected the first class as the most important of the list, and has designed a form covering the subject "Cost of Water Production" to suit the needs of present-day water service organizations. This form is presented herewith as Exhibit "A," with the understanding that supporting forms for this record are to be designed and submitted, after final approval of the cost record form.

Cost of Water Production

This form is designed to be a permanent record of the cost of water production, and as such to be kept in the headquarters of the official having charge of the water supply for division or system.

The title "Cost of Water Production" is believed to cover the subject intended, adequately. The form as designed can be adapted to record the stations of a division or sub-division, by month or by year, or to record individual stations by month. Columns 1 to 10, inclusive, cover necessary and

----------DIVISION, MONTH OF----------
OR
STATION----------DIVISION----------

THE NORTH AND SOUTH RAILROAD
COST OF WATER PRODUCTION.

EXHIBIT "A"
FORM 1302 REVISED

STATION OR MONTH	SOURCE OF SUPPLY COMPANY OR CITY WATER	NUMBER OF ENGINES WATERED	PRODUCTION			TREATMENT				COST OF OPERATION									
			FOR ENGINES "M" GAL.	OTHER USES "M" GAL.	TOTAL "M" GAL.	AMOUNT TREATED "M" GAL.	HARDNESS GRAINS PER GAL.		INCRUSTANTS REMOVED LBS.	INSPECTION AND SUPERVISION	WATER BILL OR RENTAL	PUMPERS SALARY	ELECTRIC POWER	FUEL OIL	COAL	GASOLINE	OIL AND WASTE	HANDLING CHARGES	TOTAL COST OF OPERATION
							RAW	TREATED											
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
TOTALS																			

STATION OR MONTH	COST OF MAINTENANCE						COST OF TREATMENT											TOTAL COST OF WATER PRODUCTION	COST PER THOUSAND GALLONS			
	INT'R'ST ON INVEST'M'T	PUMPING EQUIPMENT AND PIPE LINES		BUILDINGS AND TANKS		TOTAL COST OF MAINT'N'CE	LIME		SODA ASH		COAGULANT		OTHER CHEMICALS		COST OF CHEMICALS	HANDLING CHARGE	TOTAL COST OF CHEMICALS		OPERATION	MAINT'N'CE	TREATM'NT	TOTAL
		LABOR	MATERIAL	LABOR	MATERIAL		LBS	COST	LBS	COST	LBS	COST	LBS	COST								
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
TOTALS																						

pertinent information regarding water station in question. Columns 11 to 20, inclusive, cover cost of operation, Columns 21 to 26, inclusive, cover cost of maintenance, Columns 27 to 37, cost of treatment, Column 38, total cost of water production and Columns 39 to 42, inclusive, are for the unit cost per thousand gallon for operation, maintenance, treatment and total.

Inasmuch as some railroads do not treat their water, that portion of the form relative to treatment can be left out if not wanted.

The form should be printed to conform to standard size of the company using, and can be made up of two individual sheets, or the record can be kept in a loose leaf book, with headings printed on both sides of the form.

This form supersedes form 1302 now in the Manual, and is believed to be adapted to present-day water service organization.

Form No. 1302—Revised is presented to the Association this year as information.

Appendix E

(8) STUDY AND REPORT ON ACCOUNTING FOR INDUSTRY TRACKS IN ITS RELATION TO OWNERSHIP AND CONTRACT PROVISIONS, COLLABORATING WITH COMMITTEE XX—UNIFORM GENERAL CONTRACT FORMS

James Stephenson, Chairman, Sub-Committee; Anton Anderson, E. S. Butler, E. B. Crane, W. F. Cummings, C. A. Knowles, G. R. Walsh, J. W. Webster, A. P. Weymouth, K. G. Williams.

This Sub-Committee has, during the past year, made further study of the above assignment and have concluded that the progress report as submitted last year, which is to be found in Vol. 31 of the Proceedings at pages 925-936 is in the main satisfactory. After considerable study and discussion the Committee recommends that the subject matter as printed at page 928 under Section 6—Accounting, be eliminated and the following substituted therefor.

(6) Accounting

(a) Accumulate cost in a suspense account and bill industry.

(b) The cost of that part of track owned by the carrier, whether or not paid for by it, should be charged to property investment account. If all or any part of this cost is borne by others the amount should be capitalized as a Donation. The amount subject to refund to the industry should be set up in a liability account, which account should be charged with refunds as made. Any unrefunded balance remaining at expiration of the contract should be credited to Profit and Loss as a Donation.

(c) Accumulate cost of maintenance in a suspense account and bill industry periodically.

Conclusion

With the approval of the above substitution the Committee recommends that the report be accepted as information.

Appendix F

(10) METHODS AND FORMS FOR MAINTAINING A RECORD OF CHANGES IN JOINTLY OWNED INTERLOCKING PLANTS, WITH RESPECT TO OWNERSHIP AND CONTRACT PROVISIONS, COLLABORATING WITH COMMITTEE X—SIGNALS AND INTERLOCKING

A. P. Weymouth, Chairman, Sub-Committee; B. A. Bertenshaw, A. Anderson, R. R. L. Bullard, E. S. Butler, W. S McFetridge, J. T. Powers, Chas. Silliman.

This is a new assignment this year, and there are many factors entering into the subject of interest to Signal Engineers, Valuation Engineers, and to other branches of railway engineering.

In the past, a large percentage of contracts covering jointly owned or used interlocking plants were silent on ownership, as the parties preparing the agreements were interested primarily in maintenance and operation, together with the obligations of the participating companies as to renewals or additions. As valuation of the railroads has developed, complications in these features have arisen since the carriers could not agree in all cases among themselves on ownership. For the basic valuation, the usual method of determining ownership by the railroads was, in the absence of contract provisions, the proportion paid by each interested company. Since valuation date, numerous changes may have been made in an Interlocking plant by one or more carriers, which would affect the physical property of only the carrier making the change, and these changes tend to further complicate the question of ownership of the total facility.

The contractual provisions required for the purpose of prescribing the division of expense between carriers for operation and maintenance can be determined on some arbitrary basis such as the number of functions used by each carrier, but percentages representing those arbitrary proportions may be out of step with the investment or agreed ownership in those plants. The contention has been made by signal men that the percentages used for dividing the Operating Expenses for operating and maintaining interlocking plants need not necessarily conform with the ownership as represented by the respective investment of the several carriers, or with the percentages found for valuation purposes.

Few carriers have attempted to keep their records of ownership in joint interlocking plants up to date. As of the date of valuation, carriers established ownership of joint interlockings largely on contractual provisions or "for valuation purposes only" based usually on investment and in the event of a disagreement between the interested carriers, the Bureau of Valuation used the property line basis. The valuation of the I.C.C. allocated to each carrier a proportionate value in the facilities. Subsequent to the valuation date changes in the joint interlocking probably change the ownership unless the contract provides specifically for joint participation in all additions or retirements, thereby maintaining the integrity of the original ownership base. If the contract does not so provide then, unless the carriers elect to participate jointly in all changes, the ownership will change, and the revised ownership can be on the "Dollar Unit Basis," or the "Property Unit Basis."

It should be impressed upon all carriers that ownership be stated definitely in every contract.

Existing contracts must, of course, be respected in matters of ownership, and new contracts will be a matter of agreement between interested parties.

It has been stated that the fact that a carrier paid for a joint interlocking plant does not indicate, nor perhaps tend to indicate that it owns the joint plant. The I.C.C. attorneys have consistently maintained in valuation matters that ownership does not in any way depend upon who paid for the property and many disputes have resulted. Many Valuation Engineers have agreed with each other that for valuation purposes only joint interlockings were owned in certain proportions as they did not wish to disturb existing contracts. Also for valuation purposes there has been established in some cases a method of equating changes subsequent to valuation date to the 1910-1914 price level. It would appear then that there may be several kinds of ownership: "contractual," "for valuation purposes only," or "for maintenance or for operation."

Suggested Methods

There are various methods that are being used, and that may be followed, in handling matters of ownership and the changing percentages of ownership due to alterations by one or more carriers in joint plants. For example, the "investment method" whereby the actual expenditure on the plant is recorded starting with the equity assigned to each carrier as of date of valuation and following through the cost of changes, either additions or retirements, made by each interested carrier, and thus arriving at a new set of percentages for any given date. This method gives no weight to the varying value of the dollars invested in the plant by the respective carriers at different periods since date of valuation.

Another method used is to perpetuate each owning carrier's so-called equity at 1910-1914 unit prices by using adjustment unit values, which may be approved by the Bureau of Valuation, and thus like installations by different carriers will receive the same values for use in determining division of ownership. The record of jointly owned property on this basis would start out with the basic engineering report "reproduction—new" value as set up in adjustment units divided by the percentage of ownership as shown in the basic report. Following this the record is built up by A.F.E.'s using the 1910-1914 reproduction value of units added or retired. As of any desired date, the equity of each carrier at 1910-1914 prices from the adjustment units may be shown, resulting in percentages of division of ownership.

Another method that might be followed when one road's investment is in terms of, say the 1914 dollar, and the participating owner's investment is in terms of, say the 1927 dollar, would be to express the 1914 investment in terms of 1927 monetary value by the use of price trends and thus obtain new figures representing the relative equity of the respective carriers, from which new percentages of division of ownership as of the later date, in this case 1927, would result.

The A.R.A. Signal Section Manual contains in parts 86, 87, and 203, various guides and typical forms for establishing the division of ownership of jointly owned interlocking plants on a functional unit basis. This method is extensively used by many roads and should be given careful consideration.

In the A.R.E.A. Manual of 1929 there appears a Form of Agreement for Interlocking Plants, which clearly shows the investment basis as the method for establishing ownership. It is very likely that the legal aspect of this matter would be that investment by the carriers should govern in determining the ownership.

Conclusion

This being a new assignment, the report is submitted as one of progress, and the recommendation made that the subject be continued for further study, in collaboration with Committee X—Signals and Interlocking.

Appendix G

(11) USE OF MECHANICAL DEVICES FOR ACCOUNTING

John T. Powers, Chairman, Sub-Committee; B. A. Bertenshaw, C. C. Haire, J. H. Hande, C. A. Knowles, F. C. Sharood and Y. Uemura.

This is a new assignment and is a report of information only.

Mechanical devices or accessories used in engineering accounting offices such as typewriters, adding, dictating machines, slide rules, time clocks, check protectors and others are considered as auxiliary clerical aids and are not discussed here. In this report we will confine ourselves to some history and to machines used in bookkeeping, accounting and the compilation and recording of statistics.

SOME HISTORY OF FIGURES

When man first began to figure he wrote out words to illustrate his numbers. Then the Greeks devised the plan of having the first letter of the word illustrate the number Thus D (Δ) comes from the Greek word for ten (deka) from which we get "decimal." The Roman numeral system followed a similar principle. The Syrians and Hebrews used the twenty-two letters of their alphabet to represent numbers. The Phoenicians had two methods. They either wrote out numbers in words or used vertical marks for units and horizontal marks for tens. The Arabs abandoned the use of number words in the eighth century and adopted the system used by the Hindus, who shortened their number words down to the first letters. The Western Arabs modified this even further and devised what are known as Gubar (dust) numerals which are the ancestors of our modern numerals. Our system of placing our numbers so that we read 55 as fifty-five, not 5 plus 5—owes its origin to the Hindus. The Babylonians wrote their numerals with a pointed stick or stylus on soft clay tablets. The marks made by the point of the stylus are like arrowheads or wedges. The numerals thus written are called "cuneiform" numerals from the Latin "cuneus" (wedge). The mark made by the other end or blunt end of the stylus formed a circle, just as it would if you pressed the wrong end of a pencil into the clay. By pressing with only one side of the blunt end, a crescent was formed. These circles and crescents are called "Curvilinear" numerals. When the Babylonians kept accounts they used cuneiform numerals to denote debits and curvilinear numerals to denote credits, somewhat as we use black and red ink in account books today.

Once man began to write down figures, it was not long before he began to calculate. As trade grew, systems were devised for larger numbers. The decimal system was one of these. It was the general favorite because it had as its basis the fact that man has ten fingers and ten toes and that he used these in his early counting. Some systems such as the Babylonians had sixty as their basis while the Aztecs used twenty. So the Eskimos and the American Indians of the West Coast today count by twenty, using the sum of their fingers and toes as a basis. In this way large sums can be represented by simple addition. The Israelites, though rated unusually intelligent people, confined their counting to low numbers, using addition to denote large numbers. Thus they spoke of the average life of man as three score years and ten, because it was easier to count twenty (a score) three times and then add half a score (10) than it was to count up to seventy.

Ages ago, man's inventive genius turned to ways and means of saving head work in the tedious process of figuring. The ancient Arabs and Romans were just as eager to find ways of saving time and labor as are our inventors today. As trading grew more complicated some lazy genius invented a way to avoid keeping figures in his head or having to scratch them on tablets of clay. He invented a board, covered with dust, on which he could trace figures, draw columns and work with pebbles. Probably he was an Arab as this dust board was called ABACUS, from the Arabian word "Abaq" (pronounced Abacue) meaning "dust." The blackboard of the modern school room possibly is derived from the old primitive dust board. The early Greek bankers and Romans made an abacus of stone provided with grooves in which small stones called "Calculi" moved up and down. From their "Calculi" we derive our word "calculate."

The Chinese developed, and even today use the wooden abacus as you may see in some Chinese shops. The proprietor does his figuring on it and keeps his books with the familiar ink brush. Even earlier than the abacus were the "sangi" or number rods still used for computing by the Koreans and Japanese. These rods, though not used in the same way, are a reminder of the tally system in vogue in England from the time of William the Conqueror to as late as Charles II. When a man owed money he would record the amount by cutting notches in a stick called a tally stock. He would give the stick to his creditors. Sometimes dishonest creditors would cut extra notches before they presented the tally stock for payment. So the system was changed. After the notches were made the tally was split down the middle. The notches on the creditor's half then had to correspond to the notches on the debtor's half. Hence the verb "to tally," and its use in such examples as: "His figures don't tally" and "Your idea tallies with mine." Banks kept records of deposits by the tally system. Their depositors held tally stocks corresponding to those in the bank. From this came the modern word "stockholder."

The earlier system of accounting records established in England was about the time of the preparation of the historical Domesday Book, namely, a record of taxable property, about 1100. The idea of the double entry bookkeeping principle is said to have been originated by a native of Holland and first used in Italy about 1340. We are told that Roman numerals were generally used because the courts did not recognize other methods of keeping records as legal evidence.

From that time until the advent of the adding, calculating, bookkeeping, billing and punch card machines practically all calculating and accounting was done by manual pen and mental processes. Perhaps that explains why more reliable statistics of earlier years are not now available.

In comparison to the development of machinery in construction and manufacturing and the use of mechanical devices in commercial accounting, the progress has been slow in connection with the use of mechanical devices in railroad engineering offices.

Mechanical aids are of great and increasing importance. The clerical efficiency in many offices could be increased materially by the installation of accounting and statistical machines and the proper supervision of the work done upon them. We do not say that nothing should be done by hand which can be done by a machine, for the cost must be considered. The judicious use of mechanical appliances reduces to a minimum the number of actual calculations to be performed by higher salaried employes, minimizes errors and facilitates the rendering of reports and statements needed by executives when they are news, not history.

CALCULATING MACHINES

Calculating machines are divided into two distinct classes; the key driven and the crank operated.

When the keys of the direct key-driven machine (such as Burroughs and Comptometer) are depressed, the value of the keys is added and the total appears immediately in the dials.

The crank operated (such as Monroe, Mercedes, Marchant, Millionaire and Brunsviga, etc.) may be sub-divided into key sets and lever sets machines.

The crank-operated machine provides for the setting-up of the amount on the key-board and turning the amount into the dials by means of a crank or a touch bar in case of electrically operated models.

In the case of the lever set machines the amount is set up by means of a lever and turned into the dials by means of a crank.

The process of arriving at answers to problems in addition, subtraction, multiplication and division varies in the different types of machines. The key-driven type of machine requires skilled operators and considerable training is necessary to obtain maximum efficiency on this type of machine. The Burroughs Company, however, are now manufacturing an electric machine of this type which, it is claimed, will produce more accurate results quicker with a far shorter training period.

The crank-operated type of machine does not require skilled operators. Therefore, it is necessary on deciding on a particular type of calculating machine to analyze the figure work to find out the relative amount of time spent on the four branches of arithmetic.

It should be determined whether the operation is a simple one or a complicated one; how fast the machines can work and how many kinds of figure work they can do; how durable they are, and the cost.

It should be determined whether the machine is to be used by all of the clerks in the office, or, only one skilled operator.

Speed is one of the important considerations in the selection of a calculating machine. The construction of some machines permits greater speed than others.

The characteristics of the key-driven machines are:

Full keyboard, answer dials located below the keyboard and a lever or motor bar at the side which clears the dial. The capacity of the machines vary from 6 to 20 banks.

The principles involved in this class of calculator are that multiplication and division are performed as variations of additions and subtractions.

The characteristics of the crank-operated calculators—key-set calculators are:

To figure with this class of calculators the amount is first set up on the key-board and turned into the machines by means of a crank; if hand operated, or by a touch bar if motor driven. A movable carriage, which is located above the key-board has two sets of counters which affords visibility through dials. One of the sets of dials registers the result in each of the four arithmetical problems—that is, the sum in addition, the product in multiplication, the minuend in subtraction and the quotient in division.

The other set of dials which is smaller in size shows only the multiplier in multiplication and the divisor in division.

A distinct method of operation is used for each arithmetical process. When adding by means of a calculator the amounts are set up on the key-board in much the same manner as when operating an adding machine. By turning the handle or depressing the touch bar the total sum is registered in the dial. When subtracting, the amount from which the number is to be subtracted is set up first and then the amount to be subtracted. The result will be registered in the total dial. Multiplication is consecutive addition. Division is consecutive subtraction.

Machines are made in various sizes; the smallest having 6 key board columns, 6 upper dial positions and 12 lower dial positions, the largest having 10 keyboard columns, 10 upper dial positions and 20 lower dial positions. This type of machine will accomplish the addition and subtraction of fractions, registering the result in whole numbers and in fractions.

In automatic calculators, that is, electric calculators, the advantages are increased speed and the elimination of physical effort.

Lever-set calculators—columns of levers operated through openings in the cover of the machine characterize this type. The operation is accomplished by setting the levers at the amount indicated along the slots. When the amount has been set up by means of the levers, it is turned into the machine by operating a crank.

Like the key set type, the lever set machine is constructed with a movable carriage and visible dial.

PUNCH CARD ACCOUNTING AND STATISTICAL MACHINES

At the present time there are three types of accounting and tabulating machine equipment on the market; one which operates by mechanical contact, known as the Powers (manufactured by the Remington Rand Business Service Incorporated), another, the Hollerith, operates by electrical contact (manufactured by the Tabulating Machine Division of the International Business Machine Corporation) and the third which operates on the adding machine principle (manufactured by the National Cash Register Company and the Burroughs Adding Machine Company). The differences between the

three types of machines are that in the first two the cards are punched according to data taken from written records, and in the third a visible audit sheet is made within the machine.

The first two methods of tabulating (mechanical and electrical contact) are dependent upon four devices—cards, punches, sorters and tabulators. In each system the basic record is a flexible card measuring 7⅜ by 3¼ inches or 5⅝ by 3¼ inches on which is printed a form designed for the user for a particular purpose.

The cards vary in size from 34 columns to 45 and 80 vertical columns; each column numbered from naught to 9 or naught to twelve. Each card is made out in a condensed form by using figures, letters and symbols to designate certain information.

Perforations are made by a punching machine at certain numerically arranged positions in the card from which perforations the sorting and accounting tabulating machines are automatically operated and controlled. Each perforation represents an itemized fact and as many perforations may be made as required to give every detail of each fact.

By ruling the card into columns positions are created. Each of the positions, which are sometimes called "field," designate certain facts. To further facilitate identification colored cards and manila cards with colored stripes are used.

This equipment is indispensable in large offices where a great amount of statistical tabulation is required and where the accounting system is elaborate. Their operation is marvelous. By their use statistics may be prepared and analyses made as minutely as desired. Information regarding any item or group of items may be secured in a comparatively short time. Statistics are made available promptly which otherwise would only be obtained after much laborious manual and mental work, if at all.

The first steps in the process of preparing material for accounting and tabulating machines of the first two types is the punching into cards such data as can be furnished by the records. The key punch, which is the unit that records original information, operates similar to a typewriter, but proficiency in its use can be more easily acquired. There are several variations in the types of key punches, each with a modification or improvement over the hand key punch. The Powers punch can be hooked up with a typewriter or Remington Accounting machine which records the original information in the card simultaneously with the typing of the original document in one operation. The key punch in this case may be also used as a separate unit.

Depending upon the number of holes to be punched into a card, the operator can punch from 250 to 500 cards per hour.

It is necessary in connection with an operation of this equipment to devise a system of numbers of codes (the Powers prints words and names as well as figures) depending upon the purpose of use. For example: One set of numbers may represent an operating division, another set a state, another set an A.F.E. or a valuation section, and so on. Each class of information, whether it be a numeric or alphabetical character, has a definite code or set of numbers or letters assigned. For example, a vertical line drawn between the first column of digits may be intended to code the month of the year. The second field may code the operating division or state or valuation section and so on.

The next step in the compilation of data for punched cards is sorting to any desired order. To facilitate this work machines known as sorters automatically arrange the cards in sequence of classification. The operation is carried on at the rate of about 425 cards per minute until all of the cards have passed through the machine. By this method for example—cards may be arranged in order according to job, part number, or operation, valuation section, A.F.E. number, etc., or separated by Department. Devices for counting (on Powers Machines) each classification of cards as they pass into their proper places give an accurate count of classified items which are run through the machine.

The final step in gathering data is to tabulate same in such a manner as to enable one to see exactly what the results are.

Perforated cards having been properly arranged by the sorting machine are then automatically set into the accounting and tabulating machine. The contact established through the cards causes the machine to designate and add automatically that which has been perforated into them, listing grand totals, total or sub-totals being obtained depending upon the arrangement desired for report.

As the cards pass through the machines the quantities are registered in counters which accumulate the totals of the punched information. This information is printed in detail or for totals only as desired. Printed final reports can be secured with multiple carbon copies directly from the machine on regular report forms or on plain memorandum paper. The machines vary in their operating speed from 75 cards per minute when listing all cards in detail to 150 cards per minute when handling cards for totals only. The operator inserts the cards, possibly 600 at a time into the receiving magazine of the machine and starts the machine, after which the machine automatically on changes of designation prints the detailed information and the sub and grand totals of each group.

The capacity of the tabulator is enormous since many columns of fields may be added at one time. This makes it possible to undertake tabulations which would be impractical by other methods and has led to the wide application of machinery for setting up of statistics, the cost of which would be prohibitive or impossible by manual or mental means.

One large carrier has in the past four years devoted considerable effort and thought to the application of these machines in division and accounting offices. Economies have been effected in offices to the extent that the cost of the equipment, $92,000.00 (approximately) is offset by annual payroll saving of $97,000.00. This result was not secured the first year and is not considered final, as plans have been made for some additional changes which will permit further economies and more satisfactory results. Another carrier reports substantial savings on other types of equipment for this class of work, the equipment being installed after investigating all makes, including the punched card machines.

In the United States and Canada, principally because of servicing these machines, they are rented by the manufacturers and not sold. In most other countries they are sold outright. The cost of the cards runs into a sizable sum.

The third class machines referred to is known as an accounting machine as used for analyses and auditing work rather than for posting ledgers and statements. They are of the adding machine design and are equipped with the

usual key board for the amounts and keys to select the adding sections used to accumulate the totals. Each of the register selection keys represent whatever classification the work requires. The National Cash Register machine has the ability of accumulating to twenty-seven totals while the Burroughs accumulates up to twenty-one. A continuous record of all operations is made within the machine on the visible audit sheet. It may be used for a permanent record or as a posting medium or for checking purposes. A ticket may be issued automatically on all operations or class of operations or whenever desired.

BOOKKEEPING MACHINES

Bookkeeping machines to take care of modern accounting must provide for speed, legibility, ease and simplicity of operation and especially accuracy and control—correct adding, subtracting, computing, balancing and proving of figures; the elimination as far as possible of transcribing so easily transposed in rewriting; the making of records of the same general class at one writing; the elimination of checking, proving and hunting errors. These requirements are all successfully met by the bookkeeping machine, but the most vital factor in machine bookkeeping is the production of final results. To prove figures required at stated intervals in the minimum of time consistent with the maximum of efficiency.

The type of machines are subdivided as between cylinder machines and flat writing machines. The cylinder machine writes on forms fed around a cylinder. The flat writing machines write on forms placed under the writing head on a flat surface.

The cylinder machines are manufactured by the Remington Rand Business Service and the Underwood Typewriter Company, and by the Burroughs Adding Machine Company.

The flat writing machines are manufactured by such companies as Elliott Fisher Company.

THE CYLINDER MACHINE

When a standard typewriter is equipped with a calculating mechanism, that is, with an adding and subtracting device and decimal tabulator, the machine may be termed a cylinder machine. The typewriter may be used independently of the calculator. Additions and subtractions are accomplished by the use of registers called totalizers mounted on the rack in the front of the carriage or in some cases they are built in the machine and becomes an integral part of the machine. Where the totalizers are mounted on the rack in the front of the carriage they may be moved to any position or any column, and as many as 30 totalizers may be used depending upon the number of columns to be added and subtracted. Machines of this type are many in number and vary in design and operating features. Some are equipped for vertical adding, some for vertical and horizontal adding and in each case they are equipped to handle subtraction.

The machines can be equipped with motor carriage return which automatically returns the carriage after the last figure is written, or the carriage may be returned from an intermediate position by the depression of a lever.

By the use of the automatic arithmetical mechanism journal and ledger entries may be readily recorded and checked. They perform the same functions as the flat writing bookkeeping machine. Some of these machines are the National, Ellis, Burroughs Moon-Hopkins, Burroughs, Underwood, and Remington Rand.

FLAT WRITING BOOKKEEPING MACHINE

The design and mechanical construction differ somewhat from other types in that the writing surface is flat as distinguished from the round or cylindrical type of machine.

This type of machine is constructed with the typing unit mounted upon the writing surface so that each stroke of the key strikes down upon the paper which is placed on the writing surface. As the paper remains fixed throughout the process the carriage moves backward, forward and from side to side. The keys are arranged according to the standard typewriter. Models are of different sizes designed to handle either continuous length or cut forms, the same as on the cylindrical bookkeeping machines.

Machines of this class provide for the adding of figure items as they are written on the forms. Some add and subtract in vertical columns, others cross compute as well as add and subtract. In addition to posting ledger and statements, the flat writing machine is especially valuable for writing in bound books. The book page or ledger sheet to which the posting is to be made is placed on the writing surface and remains there during the operation without any necessity of changing the position. The position is fixed so that there is no possibility of it slipping, creeping or getting out of alignment.

These machines have excellent manifolding powers due to the fact the action of the keys is downward. Standard typewriter keyboard is provided.

Conclusions

The subject of machine application must be approached broadly and the precedent of years' standing discarded to secure a successful installation. The first thing to consider is present methods and present costs. An expensive installation in an office with a large volume of business may be economical but when that same installation is put in an office with but small volume it may be uneconomical. However, there are types and models of machines on the market that will prove good investments on any figure job in any volume. The important point is to select the proper machine. If the volume is small, the equipment will be used less each day and therefore last longer and may cost but a few cents per day.

A study of each office to determine the possibility of machine application should embrace the source of information, the volume, the clerical activity required prior to machine use and the final result desired, such as the form of report and final disposition of completed details.

This report is offered for information with the recommendation that the subject be discontinued.

Appendix H

(12) BIBLIOGRAPHY ON SUBJECTS PERTAINING TO RECORDS AND ACCOUNTS, APPEARING IN CURRENT PERIODICALS

W. T. Mead, Chairman, Sub-Committee; E. B. Crane, C. R. Harte, Alfred Holmead, H. R. Westcott, W. H. Woodbury.

The method followed in compiling this bibliography was the same as the method used last year. Each member of the sub-committee was assigned to watch certain periodicals and report his findings. The several reports were then combined.

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Appendix I

(13) BRIDGE INSPECTION REPORT FORMS COLLABORATING WITH COMMITTEES VII—WOODEN BRIDGES AND TRESTLES, VIII—MASONRY, XII—RULES AND ORGANIZATION, AND XV—IRON AND STEEL STRUCTURES

W. T. Mead, Chairman, Sub-Committee; C. C. Haire, J. T. Vitt, F. X. Soete, D. W. Smith, W. Heimerdinger, H. R. Westcott, Louis Wolf.

There are now included in the Manual two forms for the inspection of bridges, Form 1110 on page 716, for the purpose of general bridge inspection and Form 1111 on page 718 for the purpose of special inspections. The Manual also contains pages 847 to 859 inclusive, rules for the inspection of bridges.

A.

In order to make Forms 1110 and 1111 better adapted to their purpose as bridge inspection forms, a number of the larger railroads were asked to submit copies of their forms. After giving consideration to the practices of these roads and to the subject matter relating to rules now in the Manual, three bridge inspection forms, numbered 1110-Rev., 1110-A and 1110-B have been designed as follows:

Exhibit No. 1 (Form No. 1110)—Bridge Inspection Report—Covers Masonry, Steel Bridges and Trestles

This form is designed to be filled out and used by the bridge inspector going over the line for each individual masonry, steel bridge or trestle. The size of the form is 5 in. by 9½ in. and can be cut without waste from standard stock. This size will also fit a coat pocket. The sheets may be bound into a book with one or more perforated sheets above each fixed sheet or they may be used in a loose leaf field book. The form can be printed so that a duplicate carbon-copy (or a triplicate) can be made for the purpose of furnishing copies to those under whose supervision the maintenance of bridges is performed. The remarks column has been left unruled so that defects found can be referred to in detail. In the same or a separate notebook the inspector can carry a form of similar size, described below:

Exhibit No. 2 (Form No. 1110-A)—Bridge Inspection Report—Covers Wooden Boxes, and Pipe Culverts

This form is the same size as Exhibit No. 1 and designed for wooden boxes and pipe culverts. It will permit of listing a large number of these minor items on one page and in a like manner to Exhibit No. 1 duplicate (or triplicate) carbon copy can be made for filing with interested parties. Some roads may wish to show inspection of masonry boxes and arches on this form instead of on Exhibit No. 1.

Exhibit No. 3 (Form No. 1110-B)—Bridge Inspection Report

Exhibit No. 3, as can be noted, is a summary report which should be compiled from the daily inspection reports. This report necessarily is a larger form, 11 in. by 17 in., and the spaces provided will permit of showing the information from both the inspection forms, namely, Exhibits No. 1 and No. 2.

Forms 1110, 1110-A and 1110-B designed to supersede Forms 1110 and 1111 now in the Manual, are presented this year as information. When the collaboration required has been fully accomplished, they will be recommended for the Manual.

5"x9½ EXHIBIT No 1

NORTH & SOUTH R. R.

BRIDGE INSPECTION REPORT

Office of ____________

G-Denotes Good Condition F-Fair Condition P-Poor Condition-Requires Attention

__________ DIVISION __________ DISTRICT

BRIDGE No __________ LOCATION __________ LENGTH __________

KIND OF BRIDGE __________ No OF SPANS __________ HEIGHT __________

	ITEMS	CONDITION	REMARKS OR RECOMMENDATIONS
MASONRY	Foundations		
	Piers and Abutments		
	Bridge Seats		
	Bench and Wing Walls		
	Arch and Cover Stones		
	Parapet Walls		
	Painting		
	Riprap		
GIRDERS OR TRUSSES	Bed Plates and Rollers		
	Lower Flanges or Chords		
	Upper Flanges or Chords		
	Web or Diagonals		
	Counters		
	Pins or Rivets		
	Concrete Slabs		
	Line and Camber		
FLOOR SYSTEM	Floor Beams and Bearings		
	Connections		
	Reinforced Concrete Slab		
	Stringers		
	Connections		
	Hangers		
	Hand Railing and Flooring		
	Ties		
	Foot walk		
	Guard Rail		
	Spacing Timber		
	Drain Holes and Details		
BRACING	Top Laterals		
	Bottom Laterals		
	Sway Frames		
	Portals		
TRESTLES	Foundations		
	Caps and Stringers		
	Bulkheads		
	Sills		
	Piles and Posts		
	Water Barrels and Ladders		
	Bracing		
	Packing Bolts		
GENERAL	Machinery, Movable Spans		
	Vibration and Deflection		
	Approach Track		
	Track on Bridge		
	Paint		
	Date Painted		
	Cleanliness		

Date __________ 19__ Inspector __________

NOTE:—Inspector should be familiar with the rules for bridge inspection contained in the Manual

5" × 9½" EXHIBIT No. 2

NORTH & SOUTH R. R.

WOOD BOXES & PIPE CULVERTS INSPECTION REPORT

G—Denotes Good Condition. F—Fair Condition P—Poor Condition—Requires Attention

_______ DIVISION _______ DISTRICT

No.	KIND	SIZE	CONDITION	REMARKS

Date _______ 19__ Inspector _______

NOTE.—Inspector should be familiar with the rules for bridge inspection contained in the Manual

11" x 17"

EXHIBIT No 3

NORTH & SOUTH RAILROAD

Office of ______________

BRIDGE TRESTLE AND CULVERT INSPECTION REPORT

______________ DIVISION ______________ DISTRICT ______________

GENERAL DESCRIPTION			MASONRY								STEEL BRIDGES																								TRESTLES								CULVERTS		GENERAL								REMARKS OR RECOMMENDATIONS
											GIRDERS OR TRUSSES								FLOOR SYSTEM												BRACING																						
NUMBER NAME OR LOCATION	DATE OF INSPECTION	KIND OF BRIDGE	Foundations	Piers and Abutments	Bridge Seats	Bench and Wing Walls	Arch and Cover Stones	Parapet Walls	Pointing	Riprap	Bed Plates and Rollers	Lower Flanges or Chords	Upper Flanges or Chords	Web or Diagonals	Counters	Pins or Rivets	Concrete Slabs	Line and Camber	Floor Beams and Bearings	Connections	Reinforced Concrete Slab	Stringers	Connections	Hangers	Hand Railing and Flooring	Ties	Footwalk	Guard Rail	Spacing Timber	Drain Holes and Details	Top Laterals	Bottom Laterals	Sway Frames	Portals	Foundations	Caps and Stringers	Bulkheads	Sills	Piles and Posts	Water Barrels and Ladders	Bracing	Packing Bolts	Pipes	Wood Boxes	Machinery, Movable Spans	Vibration and Deflection	Approach Track	Track on Bridge	Paint	Date Painted	Cleanliness	Budget Item Number	

Appendix J

(14) METHODS USED IN RECAPTURE PROCEEDINGS

Chas. Silliman, Chairman, Sub-Committee; T. F. Darden, C. J. Geyer, W. R. Kettenring, C. A. Knowles, J. T. Powers, H. L. Ripley, W. H. Woodbury.

Your Sub-Committee, having been charged with the making of a report on the "Methods Used in Recapture Proceedings," submits the attached as a progress report only.

Changes are to be anticipated in the methods both of the Bureau and the Carriers, and further legal decisions may greatly modify the present procedure.

A movement has been started to bring about changes in the Transportation Act with reference to the determination of Value and the Recapture of so-called Excess Earnings; the proposed changes would be far-reaching in their effect. It is not possible to foresee at the time this report is closed what may take place in this matter in the Congress which convenes December, 1930.

METHODS USED IN RECAPTURE PROCEEDINGS

Section 15a of the Interstate Commerce Act (added February 28, 1920), provides for the so-called recapture of the earnings of a carrier when in excess of six per cent of the aggregate value of the railway property held for and used by it in the service of transportation. One-half of such excess is to be placed in a reserve fund established and maintained by the carrier, and the remaining one-half is to be paid to the Commission for the purpose of establishing a general railroad contingent fund.

Questionnaires were sent out and the carriers were directed to report their net earnings and the value of their property as claimed by them for the various years succeeding Federal Control. Considerable sums of money were paid to the Commission, but in almost every case this was done under protest, so that the funds so turned over have been tied up until final decision of the questions in issue is reached. The question of what is the aggregate value of the property in the various years is the controlling feature in this matter. The carriers, for the most part, have reported a figure of value reflecting the prices prevailing since the war, together with allowances for Working Capital and Going Concern.

The first case followed through to a decision was that of the St. Louis & O'Fallon Railway Co., F.D. 3908. A hearing was held in October, 1924, and a report of the Examiner presiding was submitted to the Commission February 27, 1926. In this report the position was taken that the value for recapture purposes, briefly stated, should be the basic primary valuation to which should be added net additions and betterments affecting the particular years in question. As described by Counsel for the Bureau: "The theory of the Report is that the values stated represent as nearly as can be determined what the properties in service in each of the recapture years had cost the Carrier."

On February 15, 1927, the Commission rendered a decision in this matter substantially in accord with the Examiner's report in the matter of the determination of value, and ordered the carrier to make payments developed on this theory. (124 I.C.C. 3.) The carrier applied to the United States District Court for the Eastern District of Missouri for an injunction setting aside this order of the Commission. An appeal from the decision of this Court to the United States Supreme Court resulted in a decision on May 20, 1929, setting forth, among other things, that present costs along with all other pertinent facts must be considered in fixing value. A decree was entered annulling the challenged order. (279 U.S. 461).

Prior to the Supreme Court's decision, hearing had been held before Examiners of the Commission upon a number of recapture cases and subse-

quent to that decision many if not all of these cases were reopened by the Commission for further hearings. In the resumed hearings the testimony on behalf of the Commission has been along the following lines:

Accounting Testimony

Testimony was presented by the Bureau of Accounts as to the net operating income of the carrier for the years in question. A statement was requested of the carrier as to the amounts set up as recapture liability in its income tax returns and also as to unaudited items.

Testimony was presented by the Bureau of Finance as to the settlement between the carriers and the Director-General, particularly in the matter of under-maintenance and the so-called Profit on material and supplies. The Bureau had made studies and analyses of these transactions, their position being that such items required an adjustment in the net operating income of the carriers.

Testimony was presented by the Bureau of Statistics developing when under-maintenance had been overcome and providing a factor for assigning a proper proportion of the total allowance made by the Director-General to each year.

Testimony was presented by the Accounting Section of the Bureau of Valuation setting forth the changes that had been made in the property subsequent to the basic valuation and reported under Order No. 3 returns.

Testimony was presented by the Accounting Section, also, as to the Original Cost to Date of the common carrier property used by the carrier as of the day preceding each recapture period. This was estimated in part, and, where the tentative valuations had declared that no original cost could be ascertained, the reproduction new figures of the basic valuation were used, except as to Land and Equipment, the figures for which were obtained from the carrier's returns under Valuation Orders Nos. 7 and 8. To these figures were added the net costs of additions and betterments. The statement likewise shows the original cost figures for each year, reduced in proportion to the depreciation developed in the Engineering Report. It also shows the land for transportation purposes and assessments for public improvements set up separately.

The amounts shown on this statement are exclusive of the increased cost of ties and rails made in replacements in kind over the cost of the ties and rails retired. A table showing the amounts of these excess costs of renewals is attached to be used where it is desirable to produce an original cost to date comparable with the property in use during the periods under consideration.

Engineering

In the first of the resumed hearings, Counsel for the Bureau of Valuation stated that it was their intention to explain thoroughly how unit prices were developed and the general method used by the Bureau in arriving at the estimated cost of reproduction for the recapture years.

A witness testified as to the large amounts of cost data the Bureau had accumulated and the various sources from which additional data was being obtained. He explained that a special engineer was assigned to the development of prices for the specific accounts. The reproduction cost totals shown in the revised Engineering Reports were developed through the application of multipliers. Prices are developed for the particular year. These are compared with the 1914 prices in the basic Engineering Report and indices arrived at. Indices for the various items in an account are then weighted and a proper index for the whole account arrived at. Such indices or multipliers are then applied to the amounts developed by applying 1914 prices to the revised quantities.

By proper weighting, a composite index for a particular road as a whole can be obtained for any one year. Similarly, composite indices for a group of railroads can be developed.

As a result of their studies, the Bureau was convinced that 1920 prices could not be considered a part of any well established plateau of prices. Prices as of 1921-1928 did show a fairly well established plateau. While the

Bureau felt the trends they had developed were reliable for broad application, they pointed out that in developing reproduction costs they considered any local conditions peculiar to the carrier in question which would affect its cost.

Copy of this general testimony was introduced in each of the other recapture cases.

Revised Engineering Reports for the years under consideration were presented by another witness. These, it was said, were based on the quantities in existence and used at a given date, to which were applied normal construction and maintenance costs. Depreciation was arrived at by the methods of Bureau of Valuation Memorandum 226, dated Nov. 6, 1915 (75 I.C.C. 183) supplemented by data from the annual reports and recent inspection. Only *summary* sheets for each year were submitted and placed in the record.

Two sets of reproduction figures were reported, one developed by the use of so-called "Spot Indices" reflecting prices for each year, and the other, "Period Indices" reflecting average prices over a period of years, such as 1921-1924, 1921-1928, the Witness expressing the opinion that the period figures 1921-1928 were the more representative and recommended their use.

A special witness testified as to Grading prices and how he had reached his conclusions. Determination of proper reproduction prices is based on two methods: (1) Consideration of current contract grading cost data, and (2) the *trend method,* developing a ratio of later day prices to the 1910-1914 prices, the purpose of the latter being to bridge gaps in those parts of the country where post-war grading data is either lacking or negligible. Prices determined by these methods are compared with the basic engineering report prices to develop the index numbers used for the revised engineering reports.

A special witness testified as to the cost of Structural Steel and other items in Account No. 6, and from these costs, by comparison with the basic engineering prices, a composite index for this Account as a whole and for this Carrier was developed.

A special witness testified as to Account No. 9—Rail, and Account No. 10—Other Track Material, and the development of the indices reported.

A special witness testified as to Account No. 12—Tracklaying and Surfacing. Conclusions had been based on a study of country-wide construction of approximately 9,000 miles of railroad. The figures shown in the exhibit submitted were predicated on the Commission's decision in the Pennsylvania Railroad Valuation Case (I.C.C. Val. Rep. 22).

A special witness testified as to the costs of buildings, how present-day prices were developed from costs of new construction studied in connection with bills of materials. These prices were compared with the prices of the basic valuation engineering reports and indices reported.

It was explained by Counsel for the Bureau that similar methods had been applied to the other accounts, but witnesses thereto would not be presented unless requested by the carrier.

Land

In the recapture hearings, including the original and later sessions, testimony as to land values for the various recapture years was presented by the Bureau. The methods followed were the same as in the original land appraisal. As explained by a witness, a personal examination of the property was made. All sales of property in the vicinity that could be secured were investigated and information obtained from owners and real estate experts. Sales that were inapplicable or abnormal were eliminated from the study.

After consideration of all the information, units of value were placed on the various zones into which the right of way was subdivided, the object being to develop a value for the carrier property by determining the unit values of similar adjacent and adjoining land. The question as to what part of the property was not devoted to carrier purposes was also investigated and some changes from the basic valuation recommended.

About July 1, 1928, in connection with Supplement No. 5 of Valuation Order No. 3, a circular was issued entitled "Outline of Plan for Bringing Land Valuations to December 31, 1927, and Such Other Date or Dates as May be Fixed by the Director of Valuation." This directed, among other things, that

carriers be called upon to indicate the portions of their property in which complete reappraisals are not justified; that they shall also collect and prepare lists of all sales applicable to the land where substantial changes in value are thought to have taken place; that jointly such sales will be verified and agreed upon; and that the application of the data and the fixing of unit values is to be a matter of independent action by the Land Section and the carrier concerned, but agreement as to the basic data is expected to obviate the necessity for extended discussion. Concurrently with the bringing of valuations to date, the Land Section will make the necessary appraisals for prospective recapture cases.

Depreciation

In the Richmond, Fredericksburg & Potomac Railroad case, F.D. No. 3898, the Bureau introduced a witness who testified as to the result of a recent inspection of the property (1930). The property was maintained in a thoroughly normal condition, but a review of changes that had been made since the basic valuation indicated the importance of the elements of inadequacy and obsolescence in determining service life and estimating depreciation. The advance of electrification, it was stated, must be considered, and it was pointed out that this property was admirably adapted to electrical operation.

Another witness testified as to "functional depreciation" and "physical depreciation" of equipment. The depreciation shown in the Engineering Report included functional as well as physical depreciation. Life studies are based on the equipment that has been retired in the past and include depreciation from all causes. A locomotive can be maintained as long as desired, but rapid advance has been made in locomotive design, in increased weight and improvements increasing efficiency. The witness stated that there was perhaps no true way of reading the future but the Bureau has resorted to the past as a means of so doing, knowing what is going on in the world as well.

Similar inspection is made and testimony introduced in other recapture cases.

On February 28, 1930, the Commission issued an order in F.D. No. 3643, Brimstone Railroad & Canal Company, directing the carrier to make payment within thirty days of the excess income as developed in an attached report of the Commission describing the situation in detail and the amounts due. This is of especial interest, being the first report and decision of the Commission since the O'Fallon Decision by the Supreme Court.

A study of the report in the Brimstone case makes it apparent that while the value figure reported for each year may be considered a "judgment" figure, the conclusions seem to be largely influenced by the reproduction figures for the various years developed by the use of so-called period prices rather than spot prices. Depreciation has been deducted as in the primary valuations and an estimate for land and working capital has been added. Apparently no additional allowance has been made for Going Concern.

The Carriers have most vigorously objected to the rewriting of the net operating income as proposed by the witnesses testifying as to the Federal Control settlements, and to the estimated original cost as submitted, being given weight.

As to the Engineering Report figures, for the various recapture years, the Carriers without waiving their general objection to the methods of the Bureau in determining reproduction costs, so far have not made vigorous protest except as to Accounts Nos. 3 and 12. This is also true as to the revised Land Reports. The principal point of difference, assuming the Bureau method of appraisal proper, has been as to classification as Carrier or Non-Carrier.

The new testimony of the Bureau as to Depreciation is designed, apparently, to support and justify the methods they have heretofore been applying and to emphasize and more accurately gauge the element of obsolescence. As in the past, the Carriers are objecting to the depreciation determined.

In the reopened hearing of the O'Fallon Case, two new lines of testimony were introduced, one was an exhibit presented by the Bureau justifying the

use of the 1914 reproduction figures as equivalent to original cost where the same could not be ascertained from the records. This study, prepared by the Accounting Section of the Bureau of Valuation, showed for about 77 carriers whose original cost or money outlay could be ascertained that these figures compared with the reproduction estimates on a 1914 basis agree on an average within about 1½ per cent. The other was testimony by the Carrier and tended to make clear that the allowance made by the Bureau for Tracklaying and Surfacing costs was insufficient and, if the character of track as estimated for by the Bureau was in actual use, the cost of maintenance for the years of recapture would include a large additional amount, which sum should be charged to operating expenses.

In the Lehigh & Hudson River Case, the Carrier endeavored to answer the testimony of the Bureau as to expenditures for under-maintenance paid for by the Government at the termination of Federal Control, by showing that, properly trended, the expenditures for maintenance during the test period were in excess of those in the years immediately following the return of the Carrier to its owners. In the testimony of the Bureau as to the so-called Profit on material and supplies returned by the Director General, the Carrier made reference to its tax case in the Federal Court wherein it was decided that this so-called Profit was not an element of operating income.

Since the tentative decision and order of the Commission in the Brimstone Railroad & Canal Co., case F.D. 3643, there have been two proposed Examiners Reports and nine tentative Findings by the Commission—all short lines except the R. F. & P. R. R. In these tentative findings it is ordered that "within the aforesaid forty days after date hereof, the Carrier, if it disagrees with the findings and conclusions of the aforesaid report, may file protest thereof, setting forth in detail each particular thing against which the protest is directed and transmit a copy of such protest to each of the parties on whom this notice is directed to be served, and file with the Commission for its official use, thirty additional copies of the same."

In these reports and tentative findings, the procedure of the Bureau as evidenced by its testimony and briefly described above was approved by the Commission. The closing paragraph in every case sets up a value for rate-making purposes for each of the years involved, the net railway operating income, and the excess net railway operating income subject to recapture.

How the value figure for rate-making purposes is arrived at is not explained, but a study of the underlying figures appearing in the reports shows that this value is a figure about midway between that of the original cost depreciated and the reproduction cost depreciated, plus the present value of the land, plus working capital.

Aside from the differences of the Carriers with the Bureau as to the details of the method in arriving at the reproduction cost and the estimated original cost, it is generally felt that the Value arrived at in these recapture hearings is not in accord with the spirit of the Supreme Court decision in the St. Louis & O'Fallon Case, and will doubtless be generally objected to.

REPORT OF COMMITTEE VI—BUILDINGS

A. L. Sparks, *Chairman;*
G. A. Belden,
E. W. Boots,
Eli Christiansen,
A. C. Copland,
E. R. Cott,
* F. M. Davison,
J. H. Davison,
W. T. Dorrance,
E. H. Dresser,
Alfred Fellheimer,
Hugo Filippi,
E. A. Harrison,
A. C. Irwin,
F. R. Judd,
W. N. Kennedy,
G. A. Rodman, *Vice-Chairman;*
A. M. Knowles,
W. L. Lozier,
D. T. Mack,
E. K. Mentzer,
R. E. Mohr,
A. H. Morrill,
J. W. Orrock,
F. L. Riley,
O. M. Rognan,
B. R. Rosenberg,
F. P. Sisson,
Arthur T. Upson,
C. L. Wenkenbach,
O. G. Wilbur,
J. C. Williams,

Committee.

* Deceased.

To the American Railway Engineering Association:

Your Committee respectfully presents herewith report covering the following subjects:

(1) Revision of Manual (Appendix A).

(2) Specifications for concrete used in railway buildings, collaborating with Committee VIII—Masonry (Appendix B).

(3) Preparation of specifications for railway buildings (Appendix C).

(4) Waterproofing and dampproofing as applied to existing buildings, collaborating with Committee VIII—Masonry (Appendix D).

(5) Various types of trainsheds and factors controlling their selection (Appendix E).

(6) Freight house doors (Appendix F).

(7) Standardization of metal buildings and parts (Appendix G).

(8) Use of welding in buildings, collaborating with Committee XV—Iron and Steel Structures (Appendix H).

(9) Furnish the Special Committee on Clearances the information required by it pertaining to buildings (Appendix I).

(10) Sidewalks and station platforms, collaborating with Committee VIII—Masonry, and XVII—Wood Preservation (Appendix J).

(11) Elevators, lifts and escalators (Appendix K).

Action Recommended

1. That the changes in the Manual in Appendix A be approved and the revised version substituted for the present recommendation in the Manual.

2. That the Specifications for Concrete used in Railway Buildings in Appendix B be received as information with a view to its being offered for publication in the Manual at a later date.

3. That the specifications mentioned in Appendix C be adopted for publication in the Manual, and that this subject be reassigned to the Committee for further consideration.

Bulletin 334, February, 1931.

4. This subject has been assigned to a special committee.

5. That this subject be reassigned as recommended in Appendix E.

6. That this subject be reassigned as recommended in Appendix F.

7. That the report in Appendix G on Standardization of Metal Buildings be received as information.

8. That the report on welding as given in Appendix H be received as information.

9. The Committee has collaborated with the Special Committee on Clearances, giving them the information requested pertaining to building clearances, which is being used in the information of their report—Appendix I.

10. That this subject be reassigned as recommended in Appendix J.

11. That the report on elevators, lifts and escalators as given in Appendix K be received as information.

Respectfully submitted,

THE COMMITTEE ON BUILDINGS,

A. L. SPARKS, *Chairman.*

Appendix A

(1) REVISION OF MANUAL

G. A. Belden, Chairman, Sub-Committee; A. C. Copland, F. M. Davison, E. K. Mentzer, O. G. Wilbur, A. L. Sparks.

It is recommended that the following revisions be made in the subject matter published in the 1929 Edition of the Manual:

1. Freight Houses, Page 268

Revise second paragraph under heading "General" to read as follows:

Present Form	*Proposed Form*
The outbound house should be not more than 30 feet wide and the inbound house should be from 40 to 60 feet wide.	Where hand trucks are to be used for trucking freight, the outbound house should be not more than 30 feet wide and the inbound house should be from 40 to 60 feet wide. Where tractors and trailers are to be used for handling freight, the width of the outbound house should be from 50 to 60 feet wide and preferably free of columns.

2. Specifications for Railway Buildings

Section 10-D, Built-up Roofing, page 320: Revise the second paragraph under "Roofing Felts" to read as follows:

Present Form	*Proposed Form*
Tarred and asphalted felts shall be rag felts, and for built-up roofing shall weigh not less than 14 lb. per 108 square feet.	Tarred felts shall be composed of rag roofing felt impregnated with a coal tar saturant, and shall weigh not less than 14 lb. per 108 square feet. Asphalt felts shall be composed of rag roofing felt impregnated with an asphaltic saturant and shall weigh not less than 14 lb. net per 108 square feet for light weight felts or 30 lb. net per 108 square feet for heavy weight felts as hereinafter specified. Asbestos felts shall be composed of genuine long fiber mineral asbestos felts impregnated with an asphaltic saturant and shall weigh not less than 14 lb. net per 108 square feet for light weight felts or 60 lb. for heavy weight felts as hereinafter specified. Felts may be furnished in widths of 32 or 36 inches. They shall be uniform in appearance, free from visible external defects, pliable, and shall not stick to such an extent as to cause tearing when unrolled.

Appendix B

(2) SPECIFICATIONS FOR CONCRETE USED IN RAILWAY BUILDINGS, COLLABORATING WITH COMMITTEE VIII—MASONRY

W. T. Dorrance, Chairman, Sub-Committee; E. H. Dresser, Hugo Filippi, A. C. Irwin, O. M. Rognan.

1. General

The Contractor shall furnish all labor, materials, tools and equipment necessary to entirely complete the work as herein specified and shown on the drawings.

MATERIALS

2. Cement

The cement shall meet the requirements of the American Railway Engineering Association, "Specifications for Portland Cement." Cement that has hardened or partially set shall not be used.

3. Fine Aggregate

Fine aggregate shall consist of sand or other approved inert materials with similar characteristics, or a combination thereof, having clean, hard, strong, durable, uncoated grains and free from injurious amounts of dust, lumps, soft or flaky particles, shale, alkali, organic matter, loam or other deleterious substances.

Natural sand which shows a color darker than the standard color when tested with the Colorimetric Test for Sands (Standard method of tests for organic impurities in sands for concrete, serial designation C 40-27, A.S.T.M.), shall not be used unless the concrete made with the materials and in the proportion to be used on the work, is shown by tests to be of the required strength.

4. Grading Fine Aggregate

Fine aggregate shall range in size from fine to coarse within the limits indicated below, percentage by weight:

Passing through No. 4 sieve	95 per cent
Passing through No. 50 sieve	
not more than	30 per cent
not less than	10 per cent
Passing through No. 100 sieve when screened dry not more than	6 per cent
Volume removed by sedimentation, not more than	3 per cent

5. Coarse Aggregate

Coarse aggregate shall consist of crushed stone, gravel or other approved inert materials, with similar characteristics or combination thereof, having clean, hard, strong, durable, uncoated particles, free from injurious amounts of soft, friable, thin, elongated or laminated pieces, alkali, organic or other deleterious matter.

If the use of crushed slag is permitted as a coarse aggregate, it shall be air-cooled, blast furnace slag, weighing not less than 70 lb. per cu. ft. and shall have seasoned not less than one year.

6. Grading Coarse Aggregate

Coarse aggregate shall range in size from fine to coarse preferably within the following limits:

Passing maximum size sieve	
not less than	95 per cent
Passing sieve ½ maximum size	
not more than	75 per cent
not less than	40 per cent
Passing No. 4 sieve	
not more than	6 per cent

The maximum size of coarse aggregate shall be not more than 3 inches and shall be not more than two-thirds of the minimum clear space between reinforcement bars or two-thirds of the size of the mesh.

7. Water

Water shall be clean, reasonably clear and free from oil, acid and injurious amounts of vegetable matter, alkali or other salts.

8. Reinforcing Materials

Steel rods or bars used for reinforcing shall conform to the requirements of the American Railway Engineering Association's "Specifications for Billet-Steel Concrete Reinforcement Bars."

Structural steel shapes used for reinforcing shall conform to the current specifications for structural steel in buildings, A.R.E.A. Steel Specifications (Bessemer Steel shall not be used).

Wire used for reinforcing and spirals for column reinforcing shall conform to the current specifications for "Cold Drawn Steel Wire for Concrete Reinforcement," of the A.S.T.M. (Serial Designation A 82-21).

All materials used in reinforcing concrete shall be free from grease, rust, scales or coating of any character which will tend to reduce or destroy the bond between the metal and the concrete.

9. Size of Bars

Reinforcement bars shall conform to the areas and equivalent sizes shown in the following table:

Size of Bar—In.	Area—Sq. In. Round Bar	Area—Sq. In. Square Bar
3/8	0.110	
1/2	0.196	0.250
5/8	0.306	
3/4	0.441	
7/8	0.601	
1	0.785	1.00
1 1/8		1.265
1 1/4		1.562

Deformed bars shall develop a bond at least 25 per cent greater than that of a plain round bar of equivalent cross-sectional area. The area of a deformed bar shall be determined by the minimum cross-section thereof.

10. Storage of Materials

Cement shall be stored in such a way as to permit easy access for proper inspection and identification of each shipment and cement that has hardened or partially set shall be removed from the site.

The fine and coarse aggregate shall be stored separately and in such manner as to avoid the inclusion of dirt and other foreign material in the concrete. Coarse aggregate shall be handled in such manner as to maintain the grading of the sizes.

Reinforcing materials shall be stored in racks which will prevent the materials from coming in contact with the ground.

WORKMANSHIP

11. Measuring

The unit of measure shall be the cubic foot; ninety-four pounds one sack or one-fourth barrel of cement shall be assumed as one cubic foot.

The method of measurement shall be such as to secure the proper proportions in each batch. The aggregate shall be measured separately by volume or weight. In volume measurement the fine aggregate and the coarse aggregate shall be measured loose, as thrown into the measuring device, due allowance being made for bulking. The water shall be so measured as to insure the desired quantity in successive batches.

12. Proportioning

The proportioning of materials for the class of concrete specified or shown on the plans shall be based on the requirements for a plastic and workable mix containing not more than the amount of water per sack (94 lb.) of cement for each class of concrete, as follows:

Class of Concrete Compression Strength Lb. per Sq. In. 28 Days	*Gallons of Water Per Sack of Cement*
3500	5.00
3000	5.50
2500	6.25
2000	7.00

These quantities of water must not be exceeded. Water in the aggregate must be included in the quantity specified and subtracted from the amount added to the mixture. The water in the aggregate shall be measured by methods satisfactory to the Engineer which will give results within one pound for each 100 lb. of aggregate.

13. Workability

The mixture shall be such as to produce concrete that can be worked readily into the corners and angles of the forms and around the reinforcement without excessive spading. The workability will be controlled by adding or deducting fine or coarse aggregate, but in no case shall the amount of coarse aggregate be such as to produce harshness in placing or honey combing in the structure.

14. Tests

The Contractor shall furnish concrete for test cylinders for compression tests made and stored in accordance with the "Current Standard Method of Making and Storing Specimens of Concrete in the Field" (Serial Designation C 31-21) of the A.S.T.M. The cylinders shall be tested in accordance with "Current Method of Making Compression Tests of Concrete" (Serial Designation C 39-25) of the A.S.T.M. Four test cylinders shall be made for each 500 cu. yd. of concrete deposited but on no job shall less than four cylinders be made. Duplicate copies of all test data taken by the Contractor for the control of concrete shall be filed with the Engineer immediately after the data is obtained.

15. Machine Mixing

The mixing of concrete unless otherwise authorized by the Engineer, shall be done in a batch mixer of approved type, which will insure a uniform distribution of the materials.

The mixer shall be equipped with suitable charging hopper, water storage and water measuring device.

The mixing of each batch shall continue not less than one and one-half minutes after all the materials are in the mixer, during which time the mixer shall rotate at a peripheral speed of about 200 ft. per minute.

16. Hand Mixing

When it is permitted to mix by hand, the mixing shall be done on a watertight platform of sufficient size to accommodate men and materials for the progressive and rapid mixing of at least two batches of concrete at the same time. The batches shall not exceed one-half (½) cu. yd. each. The materials shall be mixed dry until the mixture is of a uniform color, the required amount of water added, and the mixing continued until the batch is of a uniform consistency and character throughout.

17. Retempering

The retempering of concrete or mortar which has partially hardened, that is, remixing with or without additional cement, aggregate or water, will not be permitted.

18. Placing

Before beginning a run of concrete, hardened concrete and foreign materials shall be removed from the inner surfaces of the mixing and conveying equipment.

Before depositing concrete, all debris shall be removed from the space to be occupied by the concrete, steel reinforcing shall be secured in its proper location, forms shall be thoroughly wetted except in freezing weather unless they have been previously oiled.

Concrete shall be handled from the mixer to the place of final deposit as rapidly as practicable by methods which shall prevent the separation or loss of the ingredients. It shall be deposited in the forms as nearly as practicable in its final position. It shall be so deposited as to maintain, until the completion of the unit, a plastic surface approximately horizontal. Forms for walls or other thin sections of considerable height shall be provided with

openings, or other methods used, that will avoid accumulations of hardened concrete on the forms or metal reinforcement. Under no circumstances shall concrete that has partially hardened be deposited in the work.

19. Chuting

When concrete is conveyed by chuting, the plant shall be of such design that the angle of the chute with the horizontal shall be such as to allow the concrete to flow without separation of the ingredients. The delivery end of the chute shall be as close as possible to the point of deposit. When the operation is intermittent, the spout shall discharge into a hopper. The chute shall be thoroughly flushed with water before and after each run; the water used for this purpose shall be discharged outside the forms.

20. Compacting

Concrete, during and immediately after depositing, shall be thoroughly compacted by means of suitable tools. For thin walls of inaccessible portions of the forms, where rodding or forking is impracticable, the concrete shall be assisted into place by tapping or hammering the forms opposite the freshly deposited concrete. The concrete shall be thoroughly worked around the reinforcement and around embedded fixtures and into the corners of the forms.

21. Continuous Depositing

Concrete shall be deposited continuously until the unit of operation, approved by the Engineer, is completed.

22. Temperature

Concrete when deposited shall have a temperature not less than 50° Fahr. and not more than 120° Fahr. In freezing weather suitable means shall be used for maintaining the concrete at a temperature not lower than 50° Fahr., for not less than 72 hours after placing, or until the concrete has thoroughly hardened. The methods of heating the materials and protecting the concrete must have the approval of the Engineer. Salt, chemicals, or other foreign materials shall not be mixed with the concrete for the purpose of preventing freezing.

23. Depositing Against Other Concrete

Before depositing new concrete on or against concrete which has hardened, the forms shall be retightened, the surface of the hardened concrete shall be roughened as required by the Engineer, thoroughly cleaned of foreign matter and laitance, and saturated with water. The new concrete placed in contact with hardened or partially hardened concrete shall contain an excess of mortar. To insure this excess mortar at the juncture of the hardened and the newly deposited concrete, the cleaned and saturated surfaces of the hardened concrete, including vertical and inclined surfaces, shall first be slushed with a coating of neat cement grout against which the new concrete shall be placed before the grout has attained its initial set.

24. Protection

Exposed surfaces of concrete shall be protected from premature drying for a period of at least seven days after being deposited.

25. Forms

Forms shall be substantial and sufficiently tight to prevent leakage of mortar; they shall be properly braced or tied together so as to maintain position and shape. If adequate foundation for shores cannot be secured, trussed supports shall be provided.

Forms shall conform to the shape, lines and dimensions of the concrete as called for on the plans. Lumber used in forms for exposed surfaces shall

be dressed to a uniform thickness, and shall be free from loose knots or other defects. Joints in forms shall be horizontal or vertical. For unexposed surfaces and rough work, undressed lumber may be used. Lumber once used in forms shall have nails withdrawn, and surfaces to be in contact with face concrete thoroughly cleaned, before being used again.

Foundation concrete may be placed without forms if in the opinion of the Engineer the conditions are suitable.

Bolts and rods shall preferably be used for internal ties; they shall be so arranged that when the forms are removed no metal shall be within one inch of any surface. Wire ties will be permitted only on light and unimportant work; they shall not be used through surfaces where discoloration would be objectionable. Shores supporting successive stories shall be placed directly over those below, or so designed that the load will be transmitted directly to them. Forms shall be set to line and grade and so constructed and fastened as to produce true lines. Special care shall be used to prevent bulging.

Unless otherwise specified, suitable moldings or bevels shall be placed in the angles of forms to round or bevel the edges of the concrete.

The inside of forms shall be coated with non-staining mineral oil or other approved material or thoroughly wetted (except in freezing weather). Where oil is used, it shall be applied before the reinforcement is placed.

26. Removal of Forms

Forms shall be left in place till the concrete has attained sufficient strength to be self-supporting, and then removed only at Contractor's risk.

27. Preparing Metal Reinforcement

Metal reinforcement, before being positioned, shall be thoroughly cleaned of mill and rust scale and of coatings that might destroy or reduce the bond. Reinforcement appreciably reduced in section shall be rejected. Where there is delay in depositing concrete, reinforcement shall be reinspected and, when necessary, cleaned.

Reinforcement shall be carefully formed to the dimensions indicated on the plans. Cold bends shall be made around a pin having a diameter of three or more times the least dimension of the reinforcement bars for steel of structural grade and six or more times that for steel of intermediate or hard grade.

Metal reinforcement shall not be bent or straightened in a manner that will injure the material. Bars with kinks or bends not shown on the plans shall not be used. Heating of reinforcement will be permitted only when the entire operation is approved by the Engineer. Bars that can not be cold bent without injury shall be properly heated.

28. Placing Metal Reinforcement

Metal reinforcement shall be accurately positioned, and secured against displacement by using annealed iron wire of not less than No. 18 gage or suitable clips at intersections, and shall be supported by concrete or metal chairs or spacers, or metal hangers, unless otherwise shown on the plans. The minimum clear distance between parallel bars shall be 1½ times the diameter of round bars or 1½ times the diagonal of square bars, and bars parallel to the face of any member shall be embedded a clear distance of not less than one inch from the face.

Wherever it is necessary to splice the reinforcement otherwise than as shown on the plans, the character of the splice shall be decided by the Engineer on the basis of safe bond stress and the stress in the reinforcement at the point of splice. Splices shall not be made at points of maximum stress nor shall adjacent bars be spliced at the same point.

Splices in columns, piers and struts shall provide sufficient lap to transfer the stress by bond.

Exposed reinforcement bars intended for bonding with future extensions shall be protected from corrosion.

29. Joints

(a) When necessary to provide construction joints not indicated or specified, such joints shall be located and formed so as not to impair the strength and to impair least the appearance of the structure. Where conditions require, the joints shall be reinforced as directed by the Engineer in order to secure the necessary bond strength. Horizontal construction joints shall be prepared at the time the work is interrupted by thoroughly roughening the surface and providing keys or mortises, or by means of steel dowels set substantially at right angles to the plane of the joint.

(b) To prevent laitance in horizontal joints, excess water shall be removed from the surface forming the joint after depositing the concrete. Surfaces of contact shall be cleaned and wetted before depositing is resumed, and any laitance shall be removed.

(c) Where girders, beams and slabs are designed to be monolithic with walls and columns they shall not be cast until four hours after completion of the walls or columns in order to permit of shrinkage or settlement. In case the columns are structural steel incased in concrete, the lapse of time to allow for shrinkage or settlement need not be observed.

Joints in columns shall be made at the underside of the floor. Haunches and column capitals shall be considered as part of and to act continuous with the floor. At least four hours must elapse after depositing concrete in the columns or walls before depositing in beams, girders or slabs.

Construction joints in floors shall be located near the middle of spans of slabs, beams or girders, unless a beam intersects a girder at this point, in which case the joints in the girders shall be offset a distance equal to twice the width of the beam. Adequate provision shall be made for shear by use of inclined reinforcement.

Where watertight joints are required, sheet lead or other metal not less than six inches wide and extending the full length of the joint shall be imbedded equally in the two deposits of concrete.

30. Expansion Joints

At all expansion joints, the structure adjacent to the joint shall preferably be supported on separate columns or walls. Reinforcement shall not extend across an expansion joint; the break between the two sections shall be complete. Exposed edges of expansion joints in walls or abutments shall be rounded. Exposed expansion joints between two distinct concrete members shall be filled with an elastic joint filler of approved quality.

31. Finish

Immediately after the forms are removed, if there should be found any small pits or openings on the exposed surface of the concrete above ground or if bolts are used for securing the forms, the ends of which on removal, leave small holes, all such holes, pits, etc., shall be neatly stopped with pointing mortar of cement and fine aggregate in same proportions as used in the concrete. This mortar shall be mixed in small quantities and shall be used before same shall begin to set.

Exposed surfaces shall be made smooth. Horizontal surfaces shall be level unless otherwise shown on the drawings, and shall be leveled with straight edges. All beveled surfaces and washes shall be made true and uniform.

Exposed surfaces shall be finished as follows: The coarse aggregate shall be carefully worked back from the forms into the mass of the concrete with spades, fine stone forks, or other suitable tools, sufficient only to bring a surface of mortar against the form. Care should be taken to remove all air pockets and to prevent voids in the surface.

The forms shall be carefully removed from the surface to be finished as early as practicable, all joint marks, projections and inequalities chipped off and all voids filled with mortar made of the same proportions of cement and sand as those of the concrete.

These surfaces shall then be thoroughly wet with water, and while wet rubbed to a smooth uniform finish with a brick made of one part Portland cement and two (2) parts or two and one-half (2½) parts sand, or with a No. 3 Carborundum brick followed by a No. 30 or with a No. 24 Carborundum brick, as may be necessary to obtain the desired degree of smoothness.

No mortar or cement shall be applied except to fill distinct voids in the surface. Uneven places shall be smoothed by rubbing down and not by plastering. The surface shall be kept moist and protected from rapid drying for not less than three (3) days.

Top surfaces not subject to wear shall be smoothed with a wood float and be kept wet for at least seven days. Care shall be taken to avoid an excess of water in the concrete, and to drain or otherwise promptly remove any water that comes to the surface. Dry cement, or a dry mixture of cement and sand, shall not be sprinkled directly on the surface.

Aggregates for the wearing surface in one-course work shall have a high resistance to abrasion, and shall be screened and when necessary thoroughly washed. The least quantity of mixing water that will produce a dense concrete shall be used. The mix shall not be leaner than one part of Portland cement and 2½ parts of aggregate. The surface shall be screeded even and finished with a wooden float. Excess water shall be promptly drained or otherwise removed. Overtroweling shall be avoided.

The wearing surface in two-course work shall be placed within one-half hour after the base course. Where the wearing surface is required to be applied to a hardened base course, the latter shall be prepared by roughening with a pick or other effective tool. The roughened surface shall be thoroughly saturated with water and covered with a thin layer of neat cement paste immediately before the wearing surface is placed. The wearing course shall not be thinner than one inch.

Concrete wearing surfaces of roads and pavement made in accordance with Sections 74 and 75, shall be kept wet for at least 21 days.

32. General Conditions

All materials entering into the work and all methods used by the Contractor shall be subject to the approval of the Engineer and no part of the work will be considered as finally accepted until all of the work is completed.

The General Conditions as given in Section 1 of this specification shall be considered to apply with equal force to this section of the specification.

Appendix C

(3) PREPARATION OF SPECIFICATIONS FOR BUILDINGS FOR RAILWAY PURPOSES

F. R. Judd, Chairman, Sub-Committee; G. A. Belden, A. M. Knowles, J. W. Orrock, B. R. Rosenberg, A. T. Upson.

Specifications submitted as information to the 1930 Convention were published in Bulletin 323, pages 1204 to 1224 inclusive, under Appendix D.

It is now recommended that a portion of these specifications be adopted for publication in the Manual as follows: Section 19-F, Oil Burning Equipment; Section 24-A, Sheet Asphalt Pavements; Section 24-B, Asphalt Mastic Floors.

It is recommended, however, that instead of Article 4 of Specification 24-B, Asphalt Mastic Floors, as appearing in Bulletin 323, the following be substituted:

4-Mastic Slabs:

The mastic slabs shall be made from asphaltic cement and well graded, specially prepared mineral aggregate, both as specified hereinafter. The asphaltic cement and the aggregate shall be mixed in such proportions that the resulting mastic slab shall contain, by weight, from 12 per cent to 18 per cent bitumen. The mastic slab shall be delivered to the site of the work in convenient sizes for easy handling.

The Committee is holding in abeyance for further criticism and consideration specifications published in Bulletin 323, as follows:

Section 10D, Types D1 and D2, Asphalt Impregnated Felt Roofing over wood or precast gypsum and over concrete or poured gypsum respectively; and

Section 28, Hydraulic Elevators, Baggage and Freight.

The Committee now has in course of preparation Specifications for Reinforced Concrete Chimneys, Steel Chimneys, Electrically Operated Freight Elevators, Wood Door and Window Screens, and two additional specifications for Asphalt Impregnated Asbestos Felt Roofing, to be submitted at later dates.

The Committee recommends that this subject be reassigned for further study.

Appendix D

(4) WATERPROOFING AND DAMPPROOFING AS APPLIED TO EXISTING BUILDINGS, COLLABORATING WITH COMMITTEE VIII—MASONRY

A. H. Morrill, Chairman, Sub-Committee; A. Fellheimer, Hugo Filippi, A. C. Irwin, W. N. Kennedy, C. L. Wenkenbach, J. C. Williams.

The subject of waterproofing is being considered from other angles by two other committees, and though much work has been expended on the subject during the past year, and representatives of this Committee have met and collaborated with other committees, no written report is offered at this time because of the fact that instructions have been issued to discontinue this subject, as it is to be reassigned to a Special Waterproofing Committee composed of members of Committees VI, VIII and XV.

Appendix E

(5) VARIOUS TYPES OF TRAINSHEDS AND FACTORS CONTROLLING THEIR SELECTIONS

G. A. Rodman, Chairman, Sub-Committee; E. R. Cott, E. A. Harrison, W. L. Lozier, D. T. Mack, F. P. Sisson.

Questionnaires requesting information concerning general practice and experience of various roads have been circulated.

Considerable information has been received and tabulated, but it is the desire of the Committee that this subject be reassigned for further study and report.

Appendix F

(6) FREIGHT HOUSE DOORS

J. W. Orrock, Chairman, Sub-Committee; A. C. Copland, Eli Christiansen, E. H. Dresser, R. E. Mohr, J. C. Williams.

Questionnaires have been submitted to various railroads seeking information regarding their standard practice and experience with freight house doors. Much information has been received and tabulated, but, as more information is expected, it is the desire of the Committee that this subject be reassigned for further study.

Appendix G

(7) STANDARDIZATION OF METAL BUILDINGS AND PARTS

F. L. Riley, Chairman, Sub-Committee; G. A. Belden, E. W. Boots, J. H. Davison, A. H. Morrill, G. A. Rodman, A. T. Upson.

One story, all metal buildings, now being produced in quantity production units by various manufacturers, are suitable for certain classes of railroad work.

Buildings of this character may be dismantled and re-assembled in another location if so desired.

They are fire resistive and being manufactured in standard units of width and length gives flexibility to the layout.

Minor variations from these standards may be made to provide for light shafting, trolley crane, beams, etc., and where desired special panel lengths may be obtained.

The windows, doors, ventilators, skylights, etc., are of standard types for these buildings.

The standard units and parts are fabricated in the manufacturer's shop and may be readily erected by Company forces if so desired. The typical roof and side sheets, etc., are so designed that they are weatherproof, and when it is desired the building may be lined with wood, gypsum board or paper board for finish and insulation.

Galvanized steel frame units are obtainable for these buildings.

Units are designed for clear spans up to 100 feet, with or without monitors. On the wider sections, when convenient, interior posts are used. Saw tooth types are also obtainable.

The following is a suggested specification:

The Contractor shall furnish all labor, materials, tools and equipment necessary to entirely complete a standardized type of metal building as herein specified and as called for on the drawing.

The building shall be .... feet by .... feet, ... feet to eaves, of manufacture to be approved, and shall be of steel frame, designed to carry a roof live load of at least 25 lb. per sq. ft. unless otherwise specified on the drawings, and the design shall be in accordance with A.R.E.A. Specifications for Stresses in Structural Steel and Iron for Railway Buildings as set forth in Section 12-A, page 332 of the 1929 Manual of the Association, and subsequent revisions, or shall meet the requirements of local building codes where they exceed the above specifications.

The side wall and roof sheets shall be of approved sheets, with eaves and ridge covers to suit.

All sash and doors shall be of Manufacturer's standard sizes and types, pivoted, projected, fixed, etc., equipped with necessary hardware and glazed as indicated.

Buildings shall have side sheets of not less than 22 gauge and roof sheets of not less than 20 gauge, unless otherwise specified, and shall be of genuine wrought iron, copper bearing or other rust resisting alloy as indicated.

Provide as indicated on plans for fixed or ventilating skylights, ventilators, smoke jacks, etc.

Metal partitions shall be constructed as indicated on the plans.

All metal parts or units unless galvanized shall be given a shop coat of red lead.

Proposals shall be accompanied by general drawings furnished by the Manufacturer showing size of members and such details as will illustrate fully what it is proposed to furnish.

Successful Contractor shall furnish, for approval, full details and shall not assemble the work until such approval is received. He shall also provide plan showing anchor belt spacing and such details as necessary for foundation.

Unless otherwise specified, construction of foundations, painting and field erection, shall be done by the Railroad Company.

Appendix H

(8) USE OF WELDING IN BUILDINGS, COLLABORATING WITH COMMITTEE XV—IRON AND STEEL STRUCTURES

Hugo Filippi, Chairman, Sub-Committee; E. W. Boots, F. M. Davison, A. Fellheimer, F. R. Judd, F. L. Riley, C. L. Wenkenbach.

The practicability of welding, as a safe method of uniting component parts of a member and of combining intersecting members into a rigid structural system, has commanded attention for a number of years. Until recently, however, a lack of detailed information on the subject and of competent test data on the actual strength and behavior of welded joints has prevented a general acceptance of welding as a method suitable to building work. While much research work yet remains to be done, it is fair to say that the use of welded connections has become common. Seventy-nine cities in the United States have adopted building codes which permit fusion welding and the use of that method is no longer restricted to unimportant structures. One of the latest buildings to be erected almost wholly with welded connections is the 19 story office building of the Dallas Power & Light Company, at Dallas, Texas. It should be understood, however, that welded steel building construction may be safely undertaken only when the work is done in strict compliance with sound specifications, by thoroughly experienced operators, in accordance with drawings and specifications prepared by competent engineers, and is intelligently supervised. When these precautions are observed, the design and fabrication of welded steel members and connections for buildings may be undertaken with confidence.

There are in use today a number of distinct welding processes. A classification of these processes is indicated in Fig. 1.

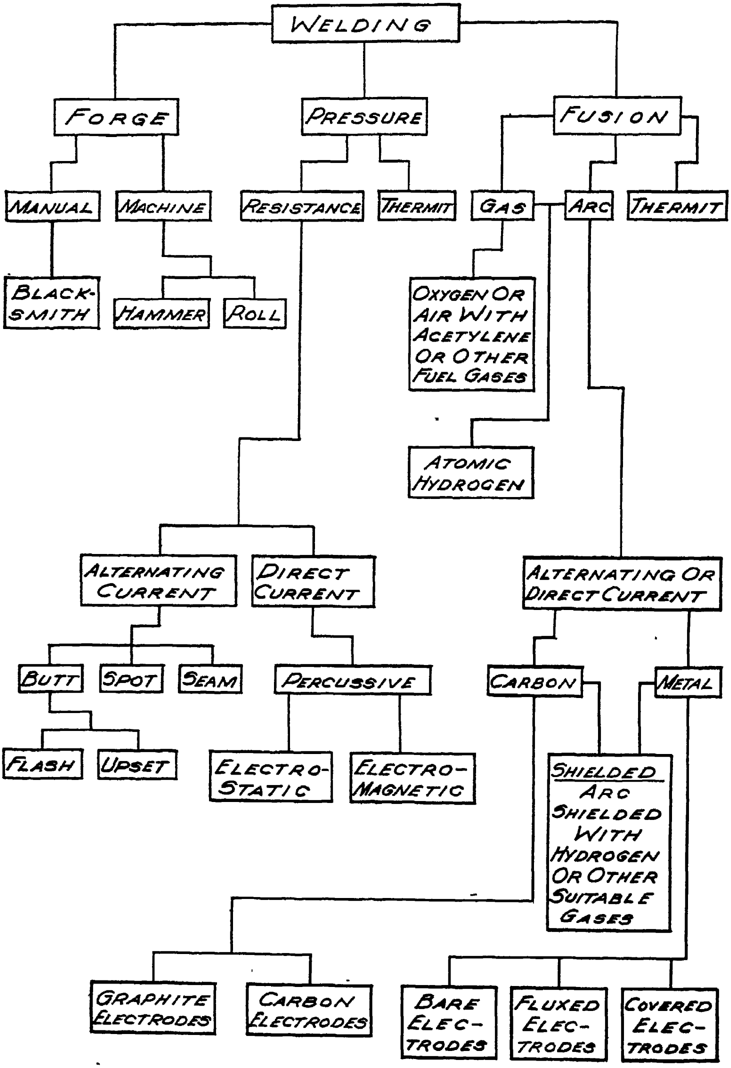


FIGURE 1

Forge Welding.—The pieces to be united are heated to the correct temperature and united mechanically by hand, under a drop hammer, or by passing through rolls.

Pressure Welding.—This type of weld may be made (a) chemically, through the use of thermit or (b) electrically, using alternating or direct current.

In Thermit Welding, the necessary heat is produced chemically by the combustion of iron oxide and powdered aluminum, which two materials when ignited, release molten metal and raise to a fusion temperature the base metal with which they come in contact, thereby forming a solid weld when the pieces are properly arranged. In some instances, pressure is then applied to the parts to be welded.

In Resistance Welding, the pieces to be united are placed in contact or nearly so and heat is generated by an electrical current passed across the junction. Due to the imperfect or incomplete contact of the two pieces of metal to be welded, a high electrical resistance is created, the base metals are highly heated and become plastic. Pressure is then applied to form the weld. This process is commonly used in fabricating shops for welding sheet metal, metal lumber and other shapes of small cross-section.

Fusion Welding.—Except in isolated cases, this method only is used in building construction. It may be divided into three general classifications:

1. Electric arc (Metallic arc, carbon arc or graphite arc)
2. Gas (Oxy-acetylene)
3. Thermit (Chemical)

In the Arc Process of Welding, the pieces of base metal to be united are heated by means of an electric arc. This arc is formed between the work to be welded and a suitable electrode or electrodes held in the operator's hand or in a machine. The electrode may be either a single piece of welding rod, in which case the process is known as Metallic Arc Welding, or the electrode may be carbon or graphite rod or rods, in which case the process is known as Carbon Arc Welding. In either case, the arc instantly heats to the melting point, a small area of the base metal. In the metallic arc method, the current passes between the work to be welded and the electrode and as it does so an arc is formed, the tip of the filler rod gradually melts off and supplies the necessary metal for the actual weld.

In the Carbon Arc Process, either one or two electrodes, of carbon or of graphite, are used. The electric arc, which passes between the two carbon electrodes, or between the electrodes and the work, creates the necessary heat for fusing the base metal, as well as for fusing a metallic filler rod if one is used, in which latter case the actual weld is formed as the end of the metallic filler rod gradually melts down and deposits its metal on the joint to be welded.

The metallic arc method, however, possesses definite advantages since this method can be used regardless of the position of the base metal to be welded, whereas the carbon arc process cannot be used for welding vertical or overhead joints. Metallic arc welding is therefore more generally used than any other process at the present time and it is of interest to note that, with few exceptions, all of the major buildings and structures fabricated and erected with welded joints during the past few years have made use of the electric metallic arc welding process.

GAS WELDING (also called oxy-acetylene welding) makes use of a flame produced by the combustion of a mixture of oxygen and acetylene gases under pressure. The resulting flame action is used as the medium for heating the surface to be welded and the metal required for the weld itself is supplied at the welding point by melting a filler rod held in the flame. This method is extensively used for repair work, and for certain industrial operations, but its use in the fabrication and erection of steel work for buildings is as yet not as common as electric arc welding.

THERMIT WELDING.—Because this method or process is so little used in building construction, no further discussion here is warranted.

As a primary introduction to the study of welding, there follows a general list of welding terms. This list was prepared by a Committee of the American Welding Society:

1. WELD.—A localized consolidation of metals.

2. WELDING PROCESS.—The method used to produce a weld.

3. FORGE WELDING.—A process of welding metals in the plastic state by means of manual or mechanical hammering. This process includes Blacksmith Welding, Hammer Welding and Roll Welding.

4. PRESSURE WELDING.—A process of welding metals in the highly plastic and/or molten states, by means of mechanical pressure. This process includes Resistance and Pressure Thermit Welding.

5. FUSION WELDING.—A process of welding metals in the molten, or molten and vaporous state without the application of mechanical pressure or blows. This process includes Gas, Arc and Fusion Thermit Welding.

6. BASE METAL.—The parent material welded or cut.

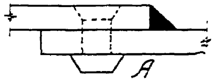
7. JOINT.—That portion of a structure wherein separate base metal parts are united.

8. WELDED JOINT.—A joint wherein separate base metal parts are united by one or more independent welds.

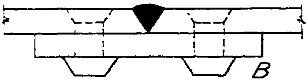
9. TYPE OF JOINT.—Joint classification based on the relative movement and/or deformation of its parts during welding.

10. Form of Joint.—Joint classification based on the arrangement and cross-sectional shape of the component parts of the joint, irrespective of the form or number of welds used to joint said parts.

11. Composite Joint.—A joint wherein welding or some other thermal process of joining metals is used in conjunction with a mechanical process to unite the separate base metal parts. See Fig. 2.



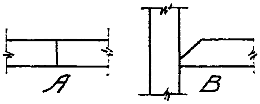
COMPOSITE JOINT



COMPOSITE STRUCTURE

FIGURE 2

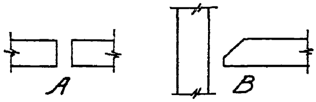
12. Composite Structure.—A structure wherein more than one method of joining its parts is used. See Fig. 2.



CLOSED JOINTS

FIGURE 3

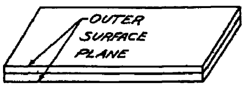
13. Closed Joint.—A term applied to a joint having its edges or surfaces in contact during welding. See Fig. 3.



OPEN JOINTS

FIGURE 4

14. Open Joint.—A term applied to a joint having its edges or surfaces spaced apart. See Fig. 4.

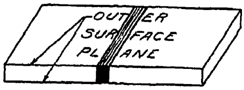


EDGE JOINT

FIGURE 5

15. Edge Joint.—A term applied to a joint obtained by the placement of a surface of one base metal part on a surface of another base metal part in such a manner that the weld joining the parts is within the outer surface planes of both of the parts joined. See Fig. 5.

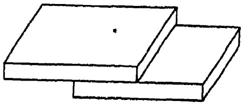
16. Butt Joint.—A term applied to a form of joint obtained by the placement of one base metal part on another base metal part, in such a manner that the weld joining the parts is between the surface planes of both of the parts joined. See Fig. 6.



BUTT JOINT

FIGURE 6

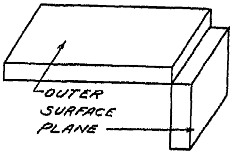
17. Lap Joint.—A term applied to a form of joint obtained by the overlapping of base metal parts, the overlapping surfaces being in the same plane. See Fig. 7.



LAP JOINT

FIGURE 7

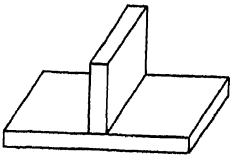
18. Corner Joint.—A term applied to a form of joint obtained by the angular placement of an edge of one base metal part on an edge or surface of another base metal part in such a manner that neither part extends beyond the outer surface plane of the other part joined. See Fig. 8.



CORNER JOINT

FIGURE 8

19. Tee Joint.—A term applied to a form of joint obtained by the angular placement of an edge of one base metal part on a surface of another base metal part in such a manner that this surface extends on both sides of the joint. See Fig. 9.



TEE JOINT

FIGURE 9

20. Form of Weld.—Weld classification based on the arrangement and cross-sectional shape of its component base metal parts, irrespective of the type or form of joint in which it is incorporated.

21. Manual Weld.—A weld made by an operator unaided by mechanically guided welding tools.

22. Automatic Weld.—A weld made by the aid of automatic equipment.

23. Semi-Automatic Weld.—A weld made partially by automatic equipment and partially by manual means.

24. Full Automatic Weld.—A weld made entirely by automatic equipment.

25. Root.—The zone at the bottom of the cross-sectional space provided to contain fusion weld. See Figs. 10 and 14.

26. Root Edge.—The joint edge at the bottom of the cross-sectional space provided to contain a fusion weld. See Fig. 11.

27. Root Face.—A joint surface of relatively small dimensions at the bottom of the cross-sectional space provided to contain a weld. See Fig. 12.

28. Throat.—The minimum thickness of a fusion weld along a straight line passing through its root. See Figs. 10 and 14. Note:—This definition is sometimes restricted so as to specifically exclude reinforcement.

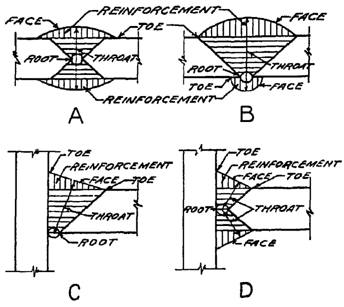


FIGURE 10

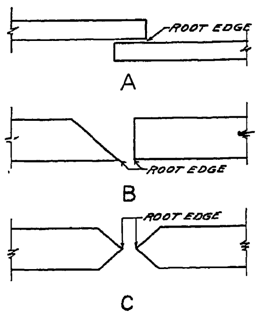
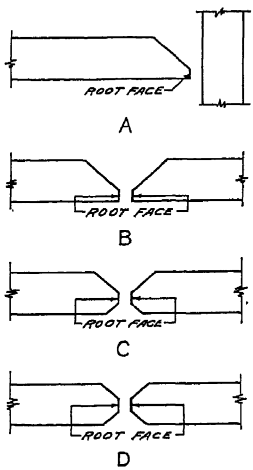


FIGURE 11



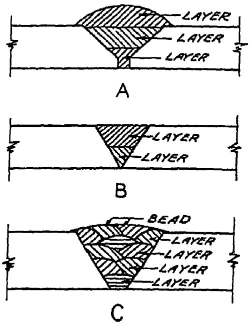


FIGURE 13

30. TOE.—The edge of a fusion weld formed by the intersection of a face and the base metal. See Figs. 10 and 14.

31. LAYER.—A stratum of weld metal of a fusion weld and consisting of one or more beads depending on the dimensions of the weld and the welding technic employed. See Fig. 13.

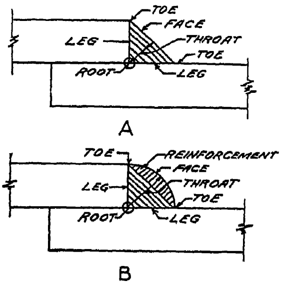
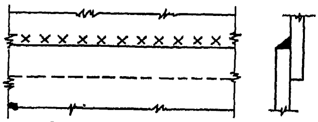


FIGURE 14

32. LEG.—One of the fusion surfaces of a fillet weld. See Fig. 14.

33. CONTINUITY.—A term used to designate the linear distribution of a weld in a welded joint.

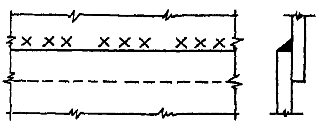
34. CONTINUOUS WELD.—A weld of unbroken continuity. See Fig. 15. Note:—All welds are understood to be continuous unless otherwise specified.



CONTINUOUS WELD

FIGURE 15

35. INTERMITTENT WELD.—A weld of broken continuity. See Fig. 16.



INTERMITTENT WELD

FIGURE 16

36. TACK WELD.—An intermittent weld used for assembly purposes only. See Fig. 17.

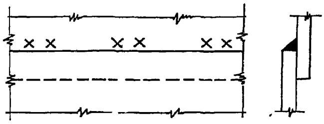

TACK WELD

FIGURE 17

37. STRENGTH WELD.—A weld intended to develop a predetermined strength.

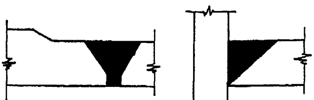
38. CAULK WELD.—A weld intended to seal a joint.

39. COMPOSITE WELD.—A weld complying with the requirements for both strength and caulk welds.

40. RIPPLE WELD.—A gas or arc weld having a surface similar to that produced by dropping a stone into still water.

41. FINISHED WELD.—A weld, the natural exposed surface of which has been modified by mechanical or thermal means to improve its appearance.

42. FLUSH.—A term applied to the exposed surfaces of fusion butt welds when the surface of the weld is even with at least one of the surfaces of the base metal parts joined. See Fig. 18.



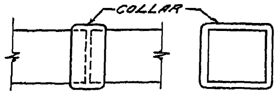
FLUSH WELDS

FIGURE 18

43. REINFORCEMENT.—Weld metal in excess of that required for standard fillet and flush butt welds. See Figs. 10 and 14.

44. REINFORCED.—A term applied to a weld provided with reinforcement.

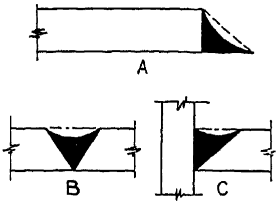
5. COLLAR.—The excess metal of a completed fusion thermit weld. See Fig. 19.



COLLAR WELD

FIGURE 19

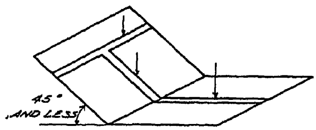
6. CONCAVE.—A term applied to a fusion butt weld when its throat thickness is less than the thickness of the thinner part joined, and to a fillet weld when its throat thickness is less than the thickness of the throat of a standard fillet weld. See Fig. 20.



CONCAVE WELDS

FIGURE 20

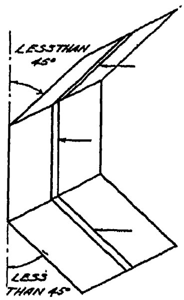
47. FLAT WELD.—A butt or fillet weld made by the fusion welding process with its linear direction horizontal or inclined at an angle of 45° or less to the horizontal, the weld being made on the upper or top side of the parts joined. See Fig. 21.



FLAT WELD

FIGURE 21

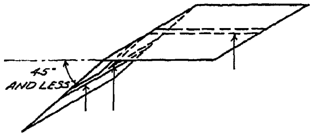
48. VERTICAL WELD.—A butt or fillet weld made by the fusion welding process with its linear direction vertical or inclined at an angle less than 45° to the vertical. See Fig. 22.



VERTICAL WELD

FIGURE 22

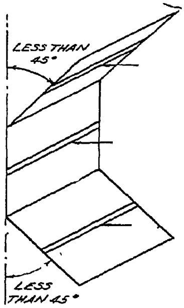
49. Overhead Weld.—A butt or fillet weld made by the fusion welding process with its linear direction horizontal or inclined to an angle less than 45° to the horizontal, the weld being made on the lower or under side of the parts joined. See Fig. 23.



OVERHEAD WELD

FIGURE 23

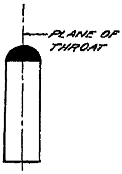
50. Horizontal Weld.—A bead or a butt weld made by the fusion welding process with its linear direction horizontal or inclined at an angle less than 45° to the horizontal, the parts welded being vertically or approximately vertically disposed. See Fig. 24.



HORIZONTAL WELD

FIGURE 24

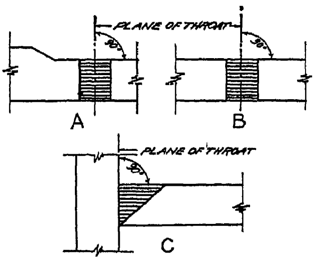
51. Edge Weld.—A form of weld whose throat lies in a plane disposed approximately in the same plane as the surfaces of the parts joined. See Fig. 25.



EDGE WELD

FIGURE 25

52. Butt Weld.—A form of weld whose throat lies in a plane disposed approximately ninety degrees (90°) with respect to the surfaces of at least one of the parts joined. See Fig. 26.



BUTT WELDS

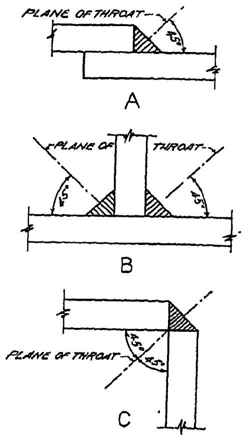
FIGURE 26

53. FILLET WELD.—A form of fusion weld of approximately triangular cross-section, and whose throat lies in a plane disposed approximately forty-five degrees (45°) with respect to the surfaces of the parts joined. See Fig. 27.

54. FILLER METAL.—Material specially prepared for addition to the weld in some forms of the fusion welding processes. (See Welding rod, electrode and thermit mixture).

55. WELD METAL.—The material composing the weld. (See Weld Metal Zone, Deposited Metal Zone, and Fusion Zone.)

56. DEPOSITED METAL.—Filler metal which has been melted by a fusion welding process. (See Filler metal.)



FILLET WELDS

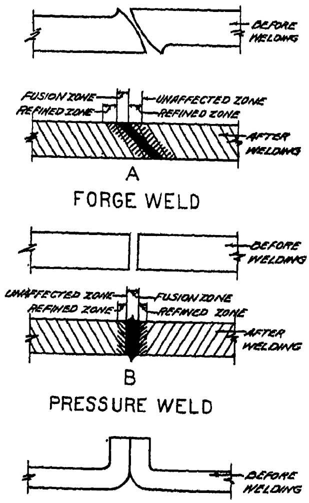
FIGURE 27

57. WELD METAL ZONE.—That portion or area of a weld which has been heated to the plastic, molten or vapor states. See Fig. 28.

58. FUSION ZONE.—That portion or area of the weld metal zone bordering on the unmelted base metal. See Fig. 28.

59. DEPOSITED METAL ZONE.—That portion or area of the weld metal zone of a fusion weld external to the original surface or edge planes provided for the weld and consisting substantially of deposited metal. See Fig. 28.

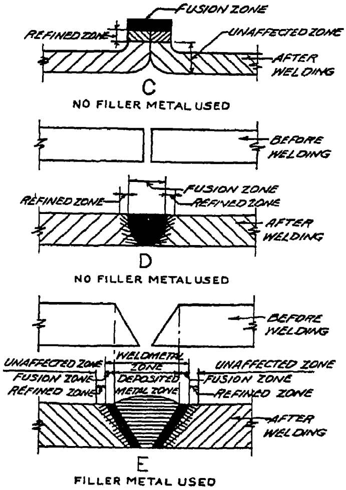
60. REFINED ZONE.—That portion or area of the base metal bordering on the fusion zone wherein grain refinement has taken place due to the welding heat. See Fig. 28.



61. UNAFFECTED ZONE.—That portion or area of the base metal outside of the refined zone wherein no change in grain size has taken place. See Fig. 28.

62. WELD PENETRATION.—A dimensional expression of the depth of the fusion zone below the original surface or edge planes of the base metal.

63. HEAT PENETRATION.—The combined depths of the fusion and refined zones below the original surface or edge planes of the base metal.



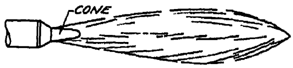
FUSION WELDS
WELDING ZONE AREAS
FIGURE 28

64. CRATER.—A convex depression in the fusion area of a weld indicating the depth of fusion.

65. GAS POCKET.—A cavity in a weld caused by the trapping of gases liberated by the metal when cooling.

66. SLAG INCLUSION. — Non-metallic material entrapped in the weld.

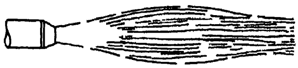
67. NEUTRAL FLAME.—A welding flame wherein the correct proportions of gases are supplied to the flame for perfect combustion. See Fig. 29.



NEUTRAL FLAME

FIGURE 29

68. CARBONIZING FLAME.—A welding flame having acetylene in excess of that required to produce a neutral flame. See Fig. 30.



CARBONIZING FLAME

FIGURE 30

69. Oxidizing Flame.—A welding flame having oxygen in excess of that required to produce a neutral flame. See Fig. 31.

OXYDIZING FLAME

FIGURE 31

70. Cone.—That part of the welding flame which is conical in shape and next to the orifice of the tip. This is the hottest part of the flame. See Figs. 29 and 31.

71. Back Fire.—Momentary retrogression of a torch flame into the torch tip, the gases re-igniting immediately following the withdrawal of the tip from the work although the use of a lighter is sometimes necessary. In either case no adjustment of the torch valves is required. Sometimes termed Preignition.

72. Flashback.—Retrogression of a torch flame into the mixing chamber or acetylene passage of the torch accompanied by a hissing or squealing sound and smoky, sharp-pointed flame of small volume, necessitating the immediate cutting off of the gas supply to prevent excessive heating and possible destruction of the torch head. A flashback usually requires the torch head to be cooled before the torch is re-lighted.

73. Rate of Flame Propogation.—The speed at which a mixture of gases burn.

74. Thermit Reaction.—The self-propagating exothermic reaction between iron oxide and aluminum which results in the formation of highly superheated liquid iron and aluminum oxide.

75. Weld Size.—A dimensional expression of the cross-section designed value of the weld. The size of a fillet weld made by the gas and arc welding processes is the designed length of its legs, and the size of a butt weld, made by the gas and arc welding processes, is its net or unreinforced throat dimension in inches.

76. Weld Length.—A dimensional expression of the unbroken length of the weld. The length of a gas or arc weld is the length of the full cross-section of the weld, exclusive of the length of any craters.

77. THERMAL STRESS.—The stress or stresses produced in a welded joint, welded structure or part cut by the heat of welding or cutting.

78. RESIDUAL STRESS.—The stress or stresses remaining in a welded joint, welded structure or part, cut on completion of welding or cutting.

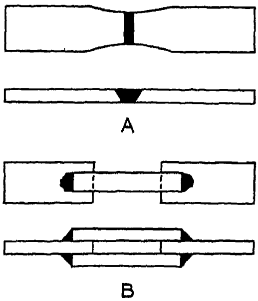
79. TEST SPECIMEN.—Material specially prepared for test purposes.

80. BASE METAL TEST SPECIMEN.—A test specimen composed wholly of base metal.

81. FILLER METAL TEST SPECIMEN.—A test specimen composed wholly of filler metal.

82. WELD METAL TEST SPECIMEN.—A test specimen having one or more welds with component base metal parts so shaped as to compel failure to take place in the weld metal. See Fig. 32.

83. WELDED JOINT TEST SPECIMEN.—A test specimen having one or more welds and primarily intended to compare the strength of the welded joint with that of the base metal.

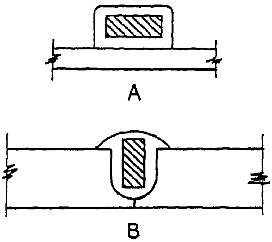


WELD METAL TEST SPECIMEN

FIGURE 32

84. DEPOSITED METAL TEST SPECIMEN.—A test specimen substantially composed of deposited metal. See Fig. 33.

85. SOLDERING.—The coating, in the molten state, of an alloy of lead and tin, on the surface of metals of a higher melting point. This process is used to coat the surface of metals or to join separate base metal parts.



DEPOSITED METAL TEST SPECIMEN

FIGURE 33

86. Brazing.—The amalgamation in the molten state of soft brass with the surface of metals of a higher melting point. It is a hard soldering process, and is sometimes used to build up a surface layer of brass or to join separate ferrous or non-ferrous base metal parts.

87. Bronze Welding.—A trade term for the application of bronze or brass to base metal of a higher melting point in essentially the same manner as in fusion welding.

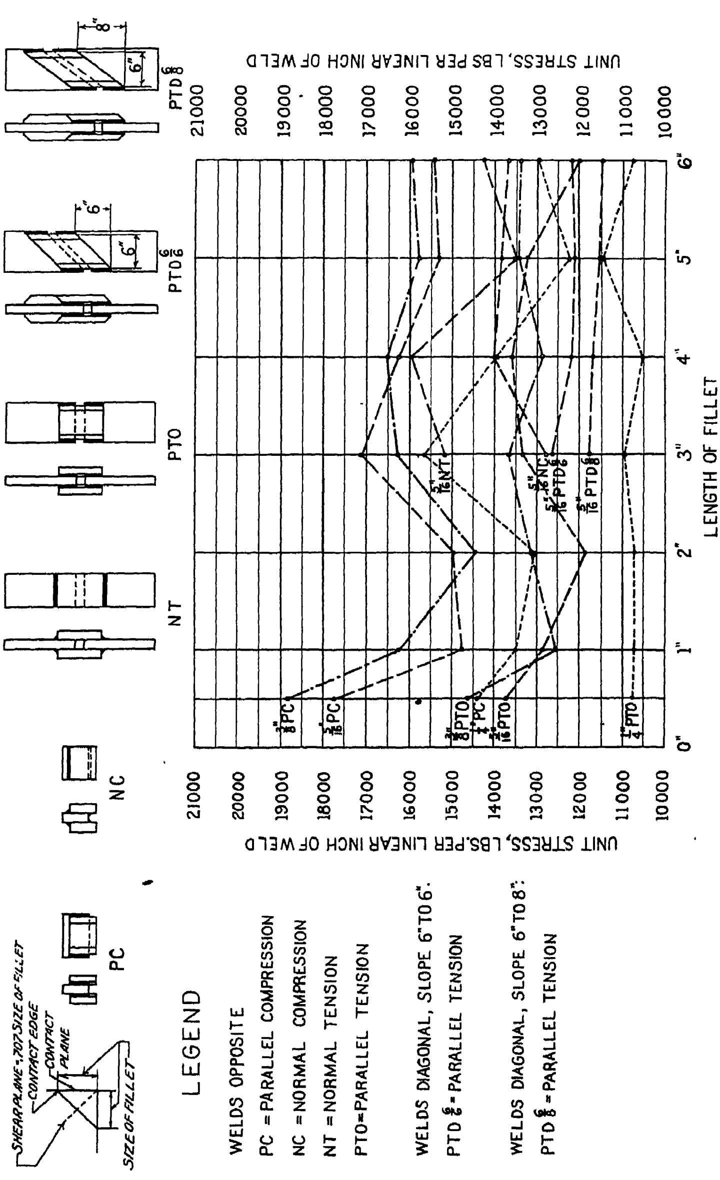


FIGURE 34 — TESTS OF 173 SPECIMENS OF METAL ARC WELDS

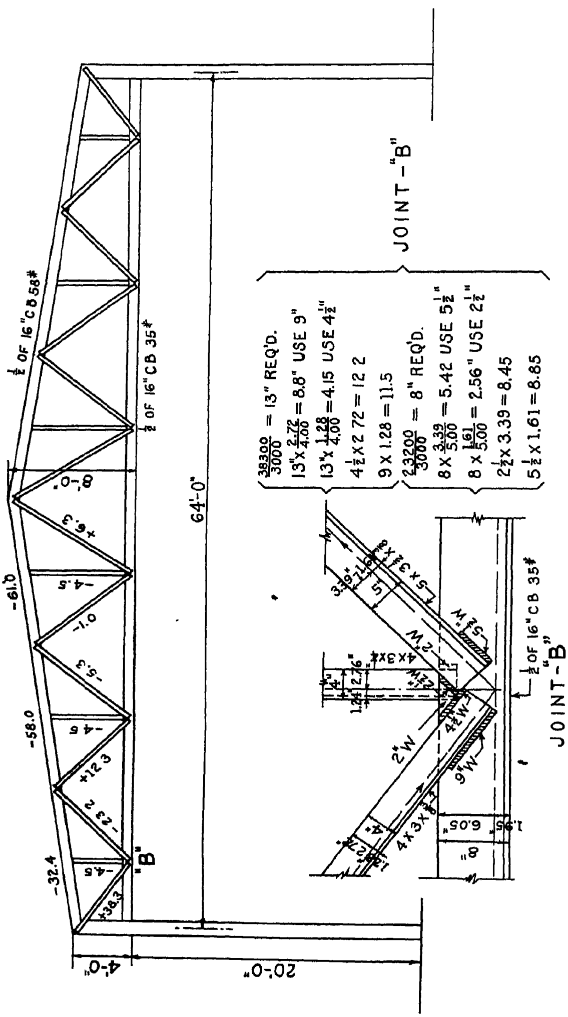


FIGURE 35 - WELDED TRUSS USING ANGLES FOR WEB MEMBERS AND ONE-HALF CARNEGIE BEAMS FOR CHORDS

WELDING SYMBOLS

	Fillet Weld	Reinforcement of Butt Weld
1. Near Side		
2. Far Side		
3 Both Sides		
4. Flush both Sides		

5. Field Weld
6. Weld all around
7. All welds continuous unless otherwise specified.
8. Size of a fillet weld is the design length of its legs
9. Size, length and C to C spacing of increments of intermittent fillet welds indicated thus: 3/8"-2"-6", if staggered thus 3/8"-2"-6"-S
10. Reinforced fillet welds indicated thus: 1/8"R
11. Depth of reinforcement of butt welds indicated thus: 1/8"
    Depth and width indicated thus: 1/8"x3/4"
12. $\boxed{\text{See Note}}$ Welding used unless otherwise specified

Note:
Specify on stamp the welding process most extensively used, viz: metal arc, gas, etc.

FIGURE 36

SUGGESTED FORM OF STAMP
TO BE USED FOR
SHOWING WELDED DETAILS
ON
DRAWINGS

SYMBOL	SYMBOLS AS USED IN PLAN AND ELEVATION: METHOD NO. 1 Preferable for all Scales	SYMBOLS AS USED IN PLAN AND ELEVATION: METHOD NO. 2 May be used for Scales ½" and above	METHOD USED FOR SECTIONS
× × × Fillet weld on near side of joint	Note-1 × × ×	Note-1	Note-1
Fillet weld on far side of joint	Note-1	Note-1	Note-1
Fillet weld on both sides of joint	Note-1	Note-1	Note-1
Fillet weld all around	Note-1 Note-2	Note-1	Note-1
• Fillet weld to be made in the field	Note-1 × × ×		

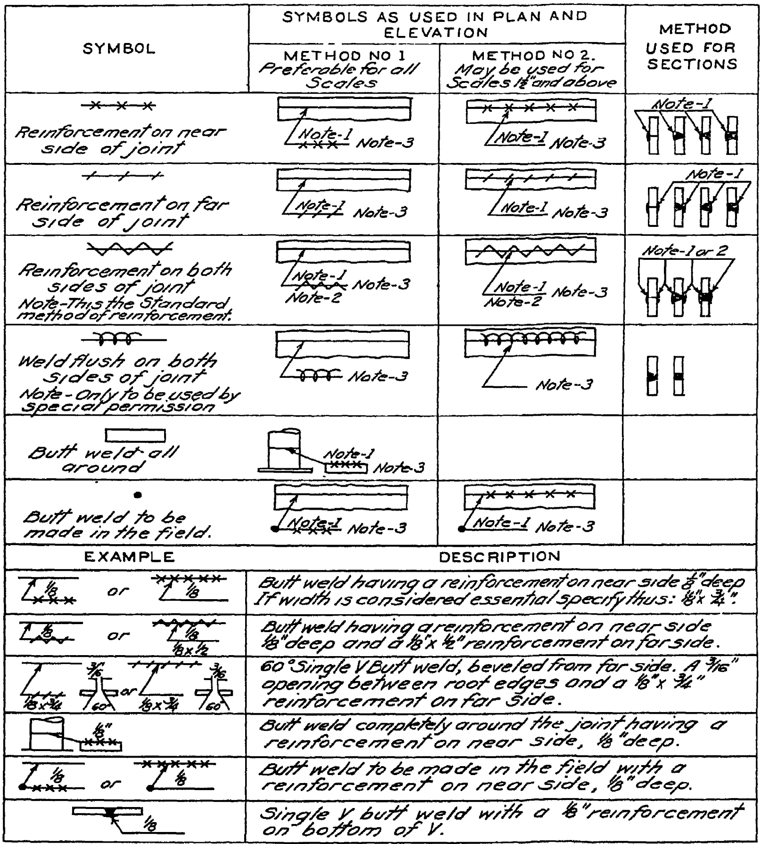
EXAMPLE	DESCRIPTION
5/16 or 5/16 ×××	5/16" Standard continuous fillet weld on near side of joint.
3/8-12 or 3/8-12	3/8" Standard continuous fillet weld 12" long on far side of joint.
½ R or ½ R	½" Standard reinforced continuous fillet weld on far side of joint.
××× ××× 3/8-2-6 or 3/8-2-6 ×××	3/8" Standard intermittent fillet weld on near side of joint having increments 2" long, spaced 6" C. to C.
××× 3/8-2-6S or 3/8-2-6S	3/8" Standard intermittent fillet weld on both sides of joint having increments 2" long, spaced 6" C to C. on each side and increments staggered with respect to each other.
3/8 ×××	3/8" Standard fillet weld completely around the near side of joint.
×× ×× ¼ or ¼ ×××	¼" Standard fillet weld to be made in the field on near side of joint.
3/8	3/8" Standard continuous fillet weld

Note:—
1. Give size and continuity of weld here. See examples
2. Show Symbol for location here. See examples.

FIGURE 37

CONVENTIONAL WELDING SYMBOLS
FOR
FILLET WELDS

AMERICAN WELDING SOCIETY



Note:-
1. Give size of reinforcement here in terms of depth or depth and width.
2. Give size of reinforcement on far side here, if different from size of reinforcement on near side.
3. Make free-hand sketch of joint here if shape of joint edges, spacing of root edges and side from which beveled, is not obvious The upper side of the sketch will be understood as the near side

FIGURE 38

CONVENTIONAL WELDING SYMBOLS
FOR
BUTT WELDS

AMERICAN WELDING SOCIETY

A

At the 1930 meeting of the American Welding Society, the Structural Steel Welding Committee read a report in which it was stated that favorable progress is being made in the extensive research program started several years ago by the Society on the strength of welded joints. The test program includes the preparation and test of 1677 specimens which were made up in 57 different types of joints of 191 different sizes. The task of fabricating these specimens has been divided among approximately 40 structural steel fabricating shops located throughout the United States. To date 1008 of these specimens have been made and completely tested. The welders who prepared the test joints were required to qualify in accordance with a procedure control plan formulated by the Committee. Their skill was not unusual but to qualify they were required to produce check test specimens averaging at least 45,000 lb. per square inch in the weld metal. In the tests so far made, those welders who have qualified have produced welds averaging 54,020 lb. per square inch.

An outstanding feature of the welds tested so far in the Research Committee's program is their uniformity. It is reported that the results so far obtained from welds made at widely separated structural shops are so nearly the same, when reduced to a unit strength basis of pounds per linear inch of weld, that the concentration of plotted points forms an almost solid black spot on the charts. It is further reported that welds, made both by the gas and by the electric arc methods, show no marked difference in strength.

From the data so far obtained it would appear that plate thickness has little effect on weld strengths; that butt welds show more variation than fillet welds, and that substantial uniformity and results may be expected in weld strengths when the operator is qualified in his work and when the work is done under established and well proven rules of procedure.

As the result of a study made by the Bureau of Construction and Repair, Navy Department, and reported in the Engineering News-Record of May 1, 1930, page 727, Leon C. Bibber, Senior Welding Engineer, has reached the following conclusions regarding the strength and performance of welded joints:

(1) The legs of a fillet, weld in tension are subjected to combined shear and tension, while the stress in the throat is pure tension.

(2) The stress in the throat of a theoretical full fillet weld, in tension, is exactly twice the stress in the base metal.

(3) The combined stress from shear and tension in the legs of a fillet weld in tension, equals 1.618 times the stress in the base metal.

(4) In a theoretical 45-deg. fillet weld, the legs are capable of being somewhat stronger than the throat.

(5) In welds with angles other than 45 degrees, the maximum efficiency of the parallel leg (leg parallel to direction of force) drops rapidly from infinity at a 0-degree angle to zero at a 90-degree angle, and below 60 degrees it exceeds that of the throat.

(6) The efficiency of the transverse leg exceeds the throat at angles above 50 degrees and equals that of the parallel leg at an angle of 45 degrees.

(7) Full benefit from reinforcement cannot be obtained with theoretical fillet welds.

(8) In lap joints, a width of lap of about five or six plate thicknesses is a good practical lap.

(9) Not obtaining metal-to-metal contact between the faying surfaces of fillet welds does not influence the strength of the weld. This is not true in a lap joint.

(10) The increased strength of an actual weld (1/16 in. penetration) over a theoretical one can be considered as 20 per cent.

(11) In tension, the 45-degree fillet weld is the simplest, most efficient and the most economical form of fillet weld to use.

In applying the theory to fillet welds in compression, the following conclusions were drawn:

(1) Conditions for compression are the exact opposite of those in tension, and therefore the throat of a fillet weld in compression is under pure compression and this stress is exactly twice that in the base metal. The legs are under combined shear and compression. The principal or combined stress is 1.618 times the stress in the base metal.

(2) In compression there is no bond; the full strength of the weld metal would be developed if there were no connection between the base metal and the weld metal, and therefore a mean value to apply to the legs as a whole will depend upon the values of the weld metal in compression and the bond in the shear. Also, this mean value will depend upon the ratio of the areas in shear to those in compression; for the 45-degree fillet, the areas are equal.

(3) Reinforcement of fillet welds in compression is of value.

(4) A fillet-welded lap joint should not be used as a compression member unless the joint is so stiffened that it cannot move out of line.

(5) Absence of metal-to-metal contact between the faying surfaces has no effect on the strength of a fillet-welded joint in compression.

(6) The increase in strength of an actual weld over a theoretical weld in compression can be taken as about 50 per cent.

DESIGN OF WELDED JOINTS

The method used in determining the stress in members of a welded structure is the same as would be used in a similar riveted structure. In a welded structure, however, it is perhaps more important that the center of gravity lines of intersecting members meet at a common point so that eccentricity and secondary stress may be avoided. Because of the adaptability of both standard and special shapes to welded work, greater freedom of selection is possible than in riveted work as, for example, the use of pipe and other not commonly employed shapes for web and main members. Having calculated the stresses in a member, the problem resolves itself into a determination of the type and length of weld to be used. From numerous competent tests already made it has been determined that the ultimate strength of a 1/4 inch fillet weld is 10,500 lb. or more per linear inch; of a 5/16 inch fillet weld 11,500 lb. or more per linear inch and of a 3/8 inch fillet weld 12,500 lb. or more per linear inch. It has been suggested by competent authorities, that the following unit values for electric arc welded joints are safe and may be used for design purposes:

1/4 in. fillet weld	2,000 lb. per linear inch
5/16 in. fillet weld	2,500 lb. per linear inch
3/8 in. fillet weld	3,000 lb. per linear inch

Note:—Size of weld refers to leg dimension. See definition 75.

These values are based on 173 tests of metallic arc welded joints of the types shown in Fig. 34 and provide a factor of safety of four or more. This figure also shows graphically the results of these tests.

As an illustration of the method of calculation to be used in designing welded joints there follows in Fig. 35 an example of a typical computation. The reader is also referred to the article, "A Rational Method of Welded Connection Design", by Andrew Vogel, Engineering News-Record, September 18, 1930, page 445.

In shop fabricating welded work, use is made of jigs specially designed to hold the individual members rigidly in place until the welding has been completed. In the field, erection bolts or equivalent means should be employed for temporarily supporting the members and for insuring proper alinement. The importance of clean base metal cannot be overestimated and care must be taken to see that the surfaces of the members, at the point of welding, have been freed from detrimental foreign substances by pickling, by cleaning with a wire brush or by chipping or hammering.

The rapid development of welding, as applied to building work, as well as its use in widely separated sections of the country, demands that sound rules of procedure be formulated as a basis for controlling welding design, shop practices and all field work. Such a set of rules, as complete as present knowledge permits, has been formulated as "A Code of Good Practice", by the American Welding Society and is obtainable through that source. As an aid in the drafting room, standardized conventional symbols, Figs. 36, 37 and 38 were also promulgated and approved by that Society, and are obtainable through its Secretary.

So far as compiled records indicate, it would appear that quite a number of structures have been erected wholly or in part with welded members or connections. For ready reference, a list of the structures known to the Committee is included in Exhibit A. It is recognized that this list may not be complete since additional welded structures are being erected at frequent intervals.

The experience being gained daily in shop fabrication and in the field, coupled with the scientific data resulting from a well organized and comprehensive program of scientific research, justifies the belief that welding, as a method of joining structural members, can now be used with confidence. Considerable progress has been made in the art during the last few years, and the future appears to hold the promise for continued activity. The proposed welding research program is of such a character that the structural designer should, at an early date, be in possession of the essential design data necessary for him to safely design welds for all types of joints. A great deal of research work yet remains to be done, however, before the effect of secondary stress, impact, torsion and other influences on welds are clearly understood. While welding appears to offer certain economic advantages, such as reduction in the weight of steelwork, available cost studies are as yet insufficient to justify definite conclusions or make possible fair cost comparisons.

The theory and practice of welding, as applied to the design, fabrication and erection of steel structures, is one of the outstanding developments of the steel industry during the last half century. Before it can be generally adopted, however, on a strictly competitive commercial basis, the fabricating shops of the country must necessarily be designed and equipped to accommodate the new type of work. The Engineering News-Record, in its issue of May 15, 1930, page 792, has very ably summarized this situation in the following editorial:

> "When and if welding enters the structural field as a competitor of riveting on a tonnage basis, fabricating facilities, as we now know them, must undergo a radical change. There is no present prospect that riveting will be entirely displaced, and such changes as may come will, therefore, be represented by the establishment of special welding shops in fabricating plants. A valuable indication of basic requirements for such a welding shop is given in an article in this issue of the magazine, describing a shop which has been revamped for welding, and in which several of the most important of our present welded buildings have been fabricated."

Exhibit A

PARTIAL LIST OF STRUCTURES IN THE UNITED STATES, BUILT WHOLLY OR IN PART WITH WELDED JOINTS

California

One-story building at Berkeley (Calif.). Built by Berkeley Construction Co. Dimensions 50 ft. by 250 ft. Has two 10-ton cranes.

A 60,000 sq. ft. automotive shop for the Associated Oil Co. at Emeryville (Calif.), erected in 1928.

All arc welded addition to Forest Lawn Mausoleum, Glendale (Calif.). Pacific Coast Iron & Steel Co. contractors. Includes heaviest welded truss thus far built, 95 feet span, 18 feet high. Maximum chord stress nearly 1,000,000 lbs.

Six-story addition to Pacific Mutual Life Insurance Building, 6th St., Los Angeles (Calif.). Consolidated Steel Corp. 1929. Field connections welded, except minor joints, which were bolted.

Twelve-story office building, Southern California Edison Co., Los Angeles (Calif.), by Consolidated Steel Corp. Work now starting. 75 to 80 per cent arc welded, balance shop riveted. Very large wind and earthquake bending stresses at column connections. About 3,000 tons of steel.

One-story warehouse, 100 ft. wide, 220 ft. long, with a 10-ft. lean-to on one side, are welded in 1928 for Capital Rice Mills, Sacramento (Calif.). Building has two main aisles on steel columns supporting roof trusses with 50-ft. spans.

Connecticut

Shop building, 42 ft. long, 66 ft. wide, connecting existing building 44 and 45 at Bridgeport (Conn.), plant of General Electric Co. Has four trusses of 64 ft. span supported on steel columns. Fabricated by American Bridge Co. Erected by Leak & Nelson Co., Bridgeport. Built 1928.

Thames River Steam Power Plant of Eastern Connecticut Power Co., Montville (Conn.), provided in 1929 with additional steel wind bracing arc welded by United Engineers and Constructors. Building 60 ft. wide by 147 ft. long.

Yale University Library, New Haven (Conn.), 150 ft. wide by 220 ft. long, 150 ft. high; supports for book stacks arc welded. Built 1928.

Delaware

Fourteen-story office building for the E. Dupont de Nemours Co. at Wilmington, Delaware. 1,575 tons of structural steel, shop riveted and field welded.

Florida

Several one-story garages and other buildings, up to 117 ft. spans, arc welded by Arch Engineering & Construction Co. of Orlando (Fla.). Includes packing plant 80 ft. by 225 ft. arc welded for Seaboard Airline Ry. Co. at Winter Garden (Fla.), also a packing house 117 ft. by 202 ft.

Idaho

Thirteen roof trusses of 50 ft. span; arc welded, 1929. Hecla Mining Co., Wallace (Idaho).

Illinois

Roof trusses over West Yard at Decatur (Ill.) plant of Mississippi Valley Structural Steel Co. Span 84 ft., both shop work and field splices welded.

Mill Building, one story, built by C. B. & Q. R. R. at Eola (Ill.).

Warehouse for materials of Chicago District Plant of Mississippi Valley Structural Steel Co. at Melrose Park (Ill.). Trusses, columns and crane columns are all welded. Crane, 20-ton capacity, span 84 ft. Dimensions of building, 135 ft. by 340 ft.

Two one-story buildings at Waukegan (Ill.). Built by General Boilers Company, one 25 ft. by 85 ft., the other 25 ft. by 50 ft.

Maine

Office and theatre building in Portland (Maine) has arc welded steel struts; built 1928, by Lehigh Structural Steel Co. of Allentown, Pa.

One-story factory building, arc welding, 1928, by Maine Steel Products Co., South Portland (Maine), erection and welding supervised by Manchester Engineering Co., Manchester, N. H. Building 60 ft. by 200 ft. with connecting ell 25 ft. by 80 ft. Main building has one aisle 44 ft. wide with five-ton crane and one side aisle 16 ft. wide with two-ton traveling hoist. Roof trusses and all other steel arc welded. No rivets or bolts used.

Massachusetts

Shop building No. 38 at Pittsfield (Mass.) plant of General Electric Co. Width 60 ft., length 270 ft. Three stories in part; one and two stories elsewhere. Fabricated and erected 1928 by American Bridge Co.

14 story office building for the Boston Edison Co. 1314 tons of structural steel. Shop riveted and field welded.

Michigan

One-story building constructed in Detroit (Mich.) for Barnes Wire Fence Co. This structure was entirely field welded; no bolts or rivets were used.

Steel frame of 25-story addition welded to original steel building of First National Bank Building in Detroit (Mich.) 1927.

Fifteen-story steel frame addition to J. L. Hudson Co. Department Store, Detroit (Mich.); has steel frame of 12 lower stories welded to existing building of same owner.

Steel frame of twelve story addition welded to original steel building of People's Outfitting Co., Detroit (Mich.).

Steel frame of four-story addition welded to original steel building of Detroit Trust Co.

Welding employed in some connections for addition to Michigan Bell Telephone Building in Detroit.

Additional floor welded in between original roof and original top floor of Crowley, Miller & Co. Department Store, Detroit.

Missouri

Building at St. Louis (Mo.), plant of Mississippi Valley Structural Steel Co. Dimensions 30 ft. by 50 ft. All shop work welded; field work bolted.

Roof trusses over West Yard at St. Louis (Mo.), plant of Mississippi Valley Structural Steel Co. Span 78 ft.

Six-story building of brick and concrete built 1927-1928 by Columbian Steel Tank Co. for their own use in Kansas City (Mo.), has a roof of welded tubular construction. Roof is 93 ft. by 120 ft., supported on modified bowstring welded trusses with spans of 42 ft. from center column to each side wall.

New Jersey

Six story steam power house of Chalfont and Haddon Hall Hotels, Atlantic City, N. J., built 1928 by Bethlehem Steel Co. Building 72 ft. wide, 79 ft. long, 150 ft. high. Steel tonnage, 541. All shop work on columns welded. All field connections of beams and girders at or within three feet of columns electrically welded, as were all column splices, and connections of new steel beams to steel columns in an adjoining building. Filling-in beams bolted.

Eight story existing Bamberger Building, Newark, N. J., increased in height and existing columns strengthened by arc welding in 1929.

New York

Three story and basement bank and office building. Tonawanda Power Company, North Tonawanda, N. Y., completely welded by Fort Pitt Bridge Works, 1928. 207 tons of steel.

Heavy shop building, No. 49, General Electric Company, Schenectady, N. Y., had existing riveted crane runways strengthened and re-enforced by welding plate stiffeners to runway plate girder webs, by welding flange angles to webs, cover plates to flange angles, and by welding additional flange plates.

Steel floor at Hershey Chocolate Co., New York, 24 ft. by 64 ft.

Material shed building. Built 1920 by Electric Welding Co. of America in Brooklyn. Roof trusses, 40 ft. span; tested by Department of Buildings, City of New York. Has traveling crane.

A 300-ton mill type building, 75 ft. by 260 ft. with a traveling crane erected by Carbide and Carbon Research Laboratories, Inc., in the plant of the Union Carbide Company, Niagara Falls (N. Y.) 1929.

Ohio

Garage building, Canton (Ohio) for Peerless Auto Sales Co. Two stories and basement. Building is 100 ft. by 150 ft.

Roof trusses, oxy-acetylene welded at Cincinnati Prest-O-Lite plant in 1926. Spans 27 to 48 ft.

A four story Upper Carnegie Office Building, 60 ft. by 119 ft. erected by the Austin Company, Cleveland, for the Owners Investment Co., in 1928. Arc welded. Steel tonnage 115. No rivets or bolts used in the steel frame.

Old factory building for the Lincoln Electric Co. at Cleveland. Consists of three stories and a basement and has vertical members welded; constructed in 1916. Building is 50 ft. by 130 ft.

Factory building for the Lincoln Electric Co. at Cleveland, built in 1923. Floor area 225,000 square feet. Arc welded.

Addition to factory building for the Lincoln Electric Co. at Cleveland, erected in 1929. Floor area 20,000 square feet. Crane mill type building, approximately 100 feet wide by 200 feet long, supporting 65 foot overhead travelling crane and enclosing a 2 track railroad siding. Arc welded.

Four stories added in 1928 to existing six story Rose Building, Cleveland (Ohio); old columns strengthened by arc welding. Forest City Structural Steel Co., Cleveland, fabricated, erected and welded the building.

Building at Youngstown (Ohio) built 1926 by Youngstown Welding Co. Dimensions 70 ft. by 220 ft., carries traveling crane. All field erection welded; no bolts or rivets used.

Pennsylvania

One-story building, Derry (Pa.), built 1927 for Westinghouse Electric & Manufacturing Co. by Jones & Laughlin Steel Corp. Dimensions of building 150 ft. by 460 ft. with a wing; 336 tons of steel.

One-story building at East Pittsburgh Works of the Westinghouse Co. Built 1928 and 1927; 40 ft. by 100 ft.

One-story garage at East Pittsburgh (Pa.) by Westinghouse Co. in 1926; 60 ft. by 90 ft.

Addition to chemical laboratory of Westinghouse Co. at East Pittsburgh (Pa.).

Welded building and supporting structure for Westinghouse automatic parking station at East Pittsburgh. 110 ft. high, 125 tons of steel.

Group of three Westinghouse buildings, East Pittsburgh (Pa.), one office type building 11 stories high, other buildings three stories and basement.

Group of buildings from 1 to 4 stories, involving over 1,000 tons of steel, heavy floor construction and about 80 roof trusses, micarta plant of Westinghouse Co., North Trafford (Pa.) 1929, Jones & Laughlin, contractor.

Five story building at Sharon (Pa.) for Westinghouse Electric and Mfg. Co. Built 1926 by American Bridge Co. Live load 300 lbs. per sq. ft., 790 tons of steel; 70 ft. wide, 220 ft. long, 80 ft. high.

One-story building. Built at Sharon (Pa.) for Westinghouse Electric & Mfg. Co. in 1926. Building 40 ft. by 102 ft.; 27 tons of steel. Crane runway for one ton crane.

Shop Building No. 1, West Philadelphia (Pa.), plant of General Electric Co. Approximately 1,000 tons of beams, columns and trusses. Electrically welded, 1927-28. Shop 136½ ft. wide by 551 ft. long, with a wing. Trusses 58½ ft., 77 ft., and 78 ft. spans. Has bridge cranes and wall cranes. Fabricated, erected and welded by American Bridge Company.

Rolling mill building at East Pittsburgh plant of Westinghouse Electric and Mfg. Co., 80 ft. by 120 ft. Roof trusses made entirely of "T" shapes. Steel tonnage, 65.

State Armory, Kingston (Pa.), had some braces inserted by arc welding in 1928.

Five story county office building and court house at Norristown, Montgomery County (Pa.). 800 tons of steel arc welded, 1929, in field by Mellon, Taylor and Henrickson of Philadelphia. Building 58 ft. by 201 ft. Height 94 ft.

Rhode Island

One-story shop, 53 ft. wide by 72 ft. long, erected 1928 in Providence (R. I.) by Providence Steel & Iron Co. for its own use. Roof trusses, 53 ft. span.

Texas

One-story garage at Dallas (Tex.), built by Dallas Power and Light Co. Two units, each 16 ft. by 140 ft.

Remodeling of the Neiman Marcus Building in Dallas (Tex.). A four story mercantile building adjoining an existing structure wherein the connections to the existing structure and reinforcement of its steel were done by fusion welding.

Three large steel hangars for Houston (Tex.) municipal airport. Each hangar's arch steel frame is 75 ft. wide, 125 ft. long and approximately 50 ft. high. All steel was arc welded in 1928. No bolts or rivets used.

19 story office building for the Dallas Power and Light Co. at Dallas. 1,400 tons of structural steel. Arc welded.

14 story office building for the Dallas Gas Company at Dallas. Structure designed for 22 stories. 80 per cent of shop work and 100 per cent of field work arc welded. 1,000 tons of structural steel. Erected 1930.

VIRGINIA

New hotel building, 180 ft. high; 60 ft. by 72 ft.; built 1928 by American Bridge Co. for Hotel Homestead, Hot Springs (Va.). Eleven full stories in tower portion with smaller floors within sloping roof and cupola. Tower flanked either side by six story wings, 40 ft. by 47 ft. 360 tons of steel, arc welded in shop and field.

One story steel frame building at Newport News Shipbuilding and Dry Dock Co., Newport News (Va.). Building 63 ft. by 33 ft.; carries completely welded ten ton fish belly crane.

WEST VIRGINIA

Six story new addition to Ohio Valley General Hospital, Wheeling (W. Va.), erected by R. R. Kitchen Co., 1928, all field connections arc welded; shopwork riveted. Steel tonnage 150.

WISCONSIN

Two additions, each a one story building, welded to original building of Chevrolet Motor Co. at Janesville (Wis.).

Two story boiler shop at Schuster Boiler Works, Janesville (Wis.). Building 66 ft. wide by 86 ft. long. No bolts or rivets used.

Welded trusses in building for Modern Power Device Co. at Port Washington (Wis.).

Appendix I

(9) FURNISH THE SPECIAL COMMITTEE ON CLEARANCES THE INFORMATION REQUIRED BY IT PERTAINING TO BUILDINGS

O. G. Wilbur, Chairman, Sub-Committee; E. R. Cott, J. H. Davison, E. A. Harrison, E. K. Mentzer, F. P. Sisson.

The report of this Committee as published in 1930 Proceedings, and in Bulletin 323 under Appendix G, has been reviewed and the necessary drawings and information regarding clearances for buildings have been submitted to the "Special Committee on Clearances" and are being included in its report.

Appendix J

(10) SIDEWALKS AND STATION PLATFORMS, COLLABORATING WITH COMMITTEES VIII—MASONRY, AND XVII—WOOD PRESERVATION

A. C. Irwin, Chairman, Sub-Committee; A. M. Knowles, W. N. Kennedy, W. L. Lozier, R. E. Mohr, B. R. Rosenberg, O. M. Rognan.

The Committee desires to report progress on this subject and recommends that it be reassigned for further study and report.

Appendix K

(11) ELEVATORS, LIFTS AND ESCALATORS

O. G. Wilbur, Chairman, Sub-Committee; E. R. Cott, J. H. Davison, E. A. Harrison, E. K. Mentzer, F. P. Sisson.

Introduction

In developing this report on elevators, lifts and escalators for handling vertical transportation in railway terminal buildings, the Committee, in collaboration with elevator engineers, has assembled such data in this report as it was felt would be of general service to those having to provide vertical transportation service in buildings of this character. Since each installation presents its own peculiar problems, it is practically impossible to fully treat this subject in a general report. It is the intention, however, to give some information as to the apparatus available and its traffic handling capacity, together with an idea of the conditions at the present time, and the future possibilities.

The first problem to be considered is the handling of passengers to and from the various general and track levels of the modern railway terminal.

The maximum requirement is the handling of the peak passenger traffic from track platform levels to general levels communicating with waiting rooms, streets and subway or elevated transportation lines.

Transportation Between Track Platform Levels and General Levels

The passengers delivered from an arriving train of, say 8 to 12 cars, are deposited on a narrow platform which is usually 12 to 25 ft. below the level of the concourse and waiting room floor. There is a considerable amount of inconvenience if the passengers must use stairways to reach the general level, particularly in the case of rises over about fifteen feet.

Escalators

The escalator is admirably suited to the handling of this transportation as it provides continuous movement and will handle a large number of people in a given time. It is desirable to provide escalators about 4 ft. wide for this service, principally on account of the hand baggage to be carried and also to handle the people rapidly. The standard escalator operates at a thirty degree angle and usually at a speed of 90 F.P.M. Higher speed escalators are used for the higher rises, say of 50 to 75 ft. These escalators are of a type that provides for the passengers to enter and leave directly in the line of the travel and do not require long approach or discharging level movement.

The maximum capacity of escalators is:

4 ft. width	8000 passengers per hour
3 ft. width	6000 passengers per hour
2 ft. width	4000 passengers per hour

However, in consideration of the handling of baggage and a certain tendency of passengers to avoid close contact on the escalator, it would not be allowable to count on more than half the given capacity for railway platform service except perhaps in handling suburban traffic in which case there would not be much baggage and the passengers would have a tendency to

pack closer on the escalator, so that it would be permissible to use two-thirds of the maximum capacity. In observations of escalator traffic in subway stations, it has been shown that for periods of two minutes and with the 2 ft. wide escalator, the maximum capacity was exceeded due to the passengers walking on the moving stairways. For periods of about 4 to 5 minutes, it was found that the escalator operated at maximum capacity rate.

At the present time in the United States, there are no escalators operating between track and general levels in railway terminals, but two escalators are now being installed in the new West Philadelphia Station of the Pennsylvania Railroad Company. In this case the rise is about 16 ft. For some time there has been an escalator operating in the Pennsylvania Station in New York City between the general waiting room level of the Long Island Railroad and the 34th Street level. There are, however, a number of escalators operating in subway stations where there is a considerable difference in level between the track platform and the street and these escalators have been found very satisfactory for this service. They are generally run Up in the morning peak and Down in the evening peak and between the morning and evening peaks, in some cases, there is an escalator running Down and another escalator running Up.

Escalators have another advantage in connection with track platform levels in that they require less width of platform than when elevators are employed. The maximum width required for a 4 ft. escalator is six feet, while an elevator would require at least 7 ft. 6 in. and generally large units would require 8 ft. 6 in. to 9 ft.

Escalators consume a comparatively small amount of power as shown by the data in Table I and attendants are not necessary.

TABLE I

ESCALATOR POWER CONSUMPTION
4 FT. WIDE ESCALATOR

30 Degree Angle of Inclination 90 F.P.M.

Rise in Feet	*Power Input in K.W. Width Average Load*		
	Ascending	*Descending*	*Average*
10	6.4	2.4	4.4
20	9.7	1.9	5.8
35	14.7	1.2	7.95

NOTE—These figures to be multiplied by $\frac{\text{Service Hours}}{\text{Day}}$ to give Power Consumption.

A sufficient escalator capacity should be installed to take care of the peak traffic as determined by the time which it is desirable to allow for the transportation of the passengers from between track platform level and the general level. If it is assumed that 800 people arriving on a train would have to be carried in five minutes and if the escalators are 4 ft. wide and they handle at 50 per cent of maximum capacity, then they would have to take care of the passengers at the rate of 9600 per hour with each escalator handling at the rate of 4000 per hour, requiring more than two of these escalators. Since, however, a certain amount of the traffic would be taken

care of by stairways, it would appear that the typical arrangement would be one 4 ft. escalator on each side of a 60 ft. crosspassage, which would provide two entrances to escalators about 140 ft. apart.

For commuters' service it would probably be necessary to handle an entire trainload in about two minutes.

Modern escalators are started, stopped and reversed by push button control and require very little attention.

The modern type of escalator is known as the "cleat step" type. Previously, a type of escalator was used that provided a moving stairway with flat steps which moved to a position at the entering and discharging levels so that the tread of the steps formed into a moving level, the passengers stepping on and off from the side. This type has been practically discontinued for the reason that it requires considerable space at the levels and also requires the passengers to step on and off at the side, which is more or less inconvenient. The present type of escalator has the so-called "cleat top" for the steps, which is a ribbed top. At the terminals the ribs pass into a comb and the passenger steps on and off directly in the line of travel. An old type of escalator that has been practically superseded consists of moving elements attached to a chain which forms into an incline surface. In this case, the passenger stands with the feet on the incline and the transportation is decidedly uncomfortable.

Escalators are provided with safety devices which stop and hold them properly in case power should be cut off and they are also stopped and held in position in case any parts should break. The hand rails are protected so that passengers cannot get their hands caught. The safety devices in general, are such as make the modern escalator safe and comfortable for the transportation of passengers without any attendants being required at the terminals. They may also be used as stairways in periods when they are not operating.

Elevators Between Levels

The elevators used for transportation between track platform levels and general levels would usually be of 3000 to 5000 pound capacity with net platform areas of 30 to 50 square feet. A 3000 lb. elevator may have a platform 7 ft. wide by 6 ft. deep over all. Such an elevator would carry about 16 passengers per trip and assuming a 12 ft. difference in level and a speed of 150 F.P.M., one of these elevators would carry about 1300 people one way per hour. Therefore, three of these elevators would be nearly equal to one 4 ft. escalator. A 5000 lb. elevator at 350 F.P.M., carrying, say 32 passengers and assuming a difference in level of 12 ft. would handle about 1900 people per hour. The round-trip time, however, would be about one minute and since the elevator would only require about 23 seconds for loading, there would be too long wait time between cars if elevators were located in isolated positions. It would therefore be desirable to have two elevators in a group in order to reduce the interval to about 30 seconds in this case, or about 22 seconds in the case of the 3000 lb. elevators previously mentioned.

ESTIMATED POWER CONSUMPTION OF ELEVATORS OPERATING BETWEEN TWO LEVELS

Duty	*Rise Ft.*	*Type of Elev. Machine*	*Stops per Car Mile*	*Estimated Average Miles per 18-Hour Service Day*	*K.W.H. Per Car Mile*	*K.W.H. per 18-Hr. Day*
3000 lb. at 150 FPM	12	Geared Traction A.C. Resistance Control, Self-Leveling	440	3.4	13.6	46
5000 lb. at 350 FPM	50	Gearless Traction Multi-Voltage Control Self-Leveling	106	8.4	12.9	108
11000 lb. at 350 FPM	75	Gearless Traction Multi-Voltage Control Self-Leveling	70	13.5	21.2	284

The above figures are based on the assumption that the elevators are worked at an average of 45 per cent of their maximum capacity throughout the 18-hour day.

If four groups of two elevators each are provided, of 3000 lb. capacity, they would be capable of handling a platform having a peak of 800 people in five minutes.

For short rises, elevators are not as satisfactory as escalators and are usually less economical. Unless the intervals are short so that there would be a convenient elevator waiting for the passengers, the latter would probably elect to use the stairways. There would also, at times, be more congestion around the elevators than around the escalator entrances. Where elevators are provided for rises of, say 40 ft. or more, they have given very satisfactory service in handling the people between subway platform levels and general levels.

Elevators for this class of service would be best operated by an attendant and may have either push button or car switch operation. In either case, they should automatically level at the landing and maintain the car platform level with the landing for the entire time that the elevator is at the landing. Elevators of this type are in use in a number of stations. They operate very satisfactorily and at high transportation efficiency in the New York subways where they are used for rises of approximately 50 to 100 feet.

For rises of this height, elevator speeds of 350 to 500 F.P.M. are usually employed and in the more recent installations they are invariably of the gearless, self-leveling type and usually provided with multi-voltage control.

In proportioning platforms for elevators of this size, an allowance of at least 100 lb. per sq. ft. of net inside floor area is necessary as it is not unusual for such elevators to be loaded by passengers to an average of as much as 110 lb. per sq. ft. An average passenger weight of 150 lb. may be assumed.

Handling Capacity of Passenger Elevators

Table II shows the traffic handling capacity of elevators of different load capacities at different speeds with different rises when they operate between two levels without intermediate stops and are of the self-leveling type.

TABLE II

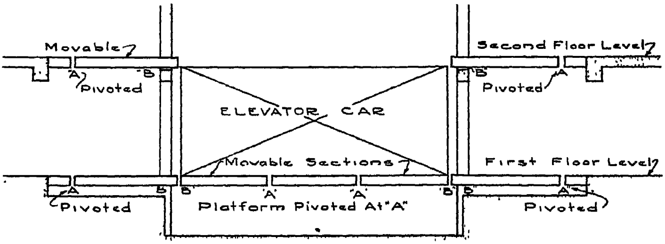
PASSENGER TRAFFIC HANDLING CAPACITY OF ELEVATORS

Approximate capacities may be determined for any speed by interpolating between figures given in this tabulation.

Rise in Feet	*Elevator Load in Pounds*	*Speed FPM*	*Round Trip Time in Sec. One Way Traffic*	*Passenger Capacity in 5 Min. One Way*	*Passenger Capacity in 1 Hr. One Way*	*Round Trip Time in Sec. Two Way Traffic*	*Passenger Capacity in 5 Min. Two Way*	*Passenger Capacity in 1 Hr. Two Way*
10	3000	150	43	111	1330	66	145	1735
10	3000	350	37	128	1535	60	160	1920
10	5000	150	66	145	1740	110	174	2090
10	5000	350	60	159	1910	104	185	2220
20	3000	150	51	94	1125	74	130	1560
20	3000	350	41	117	1400	64	150	1800
20	5000	150	74	130	1560	118	163	1960
20	5000	350	64	150	1800	108	178	2130
30	3000	150	59	81	970	82	117	1400
30	3000	350	44	109	1305	67	143	1710
30	5000	150	82	117	1400	126	152	1820
30	5000	350	67	143	1710	111	173	2075
40	3000	150	67	72	863	90	107	1280
40	3000	350	48	100	1200	71	133	1590
40	5000	150	90	107	1280	134	143	1715
40	5000	350	71	136	1630	115	167	2000
50	3000	150	75	64	767	98	97	1165
50	3000	350	51	94	1125	74	130	1555
50	5000	150	98	98	1175	142	135	1620
50	5000	350	74	130	1555	118	163	1950
60	3000	150	83	59	707	106	91	1090
60	3000	350	54	88	815	77	125	1500
60	5000	150	106	91	1090	150	128	1535
60	5000	350	77	124	1485	121	159	1900
70	3000	150	91	53	635	114	84	1008
70	3000	350	58	83	995	81	118	1415
70	5000	150	114	83	995	158	122	1465
70	5000	350	81	119	1425	125	153	1830
80	3000	150	99	48	575	122	79	946
80	3000	350	61	79	947	84	114	1365
80	5000	150	122	79	947	166	116	1390
80	5000	350	84	114	1365	128	150	1800
90	3000	150	107	45	540	130	74	887
90	3000	350	65	74	887	88	109	1308
90	5000	150	130	74	887	174	110	1315
90	5000	350	88	110	1320	132	145	1735
100	3000	150	115	42	503	138	65	778
100	3000	350	68	70	839	91	106	1270
100	5000	150	138	70	839	182	105	1255
100	5000	350	91	106	1270	135	142	1700

Baggage Elevators Between Levels

These elevators are usually of sufficient size to accommodate motor trucks. They should be self-leveling so that they stay level with the landing as the wheels of the truck pass on and off. While these baggage elevators have, until recently, been manually operated, a fully automatic elevator has been developed and a number of them are in service. The arrangement of these elevators is shown by the sketch, Fig. 1. When a truck drives onto the loading platform, the elevator, if not at the landing, is called to the landing. When the elevator arrives at the landing where the truck is waiting, the doors and gates are automatically opened. The truck then drives onto the elevator and the driver, pressing a button arranged conveniently so that he does not have to leave his seat on the truck, causes the doors to close automatically and the car to proceed to the other landing when the doors open automatically. From the time when the truck starts to drive onto the loading platform until it is completely off the other platform, there can be no interference by any other operation. This interlocking feature is obtained by the use of so-called "moveable platforms" on the elevator and on the loading and discharging landings. These are similar to scale platforms and are moved very slightly by the weight of the truck.



· FIG 1 ·

Diagram with car at lower landing. Upper landing Identical except landing Pit. Movable sections Pivoted at points marked "A". Control mechanism At points marked "B"

Freight Terminal Elevators

Before either the size, capacity or arrangement of elevators for use in freight terminals can be determined, it is necessary to study the quantity, weight and bulk of the material to be handled in the various areas of the building and the handling capacity required in peak periods of service, selecting as a base, a suitable maximum time over which the peak traffic may be averaged. It is comparatively easy to determine how much material the elevators will handle in a given time with various methods of loading and unloading and with different types of trucks and, therefore, if the estimated tonnage to be handled in a given time period of the peak is known, the number, size and speed of the elevators that will give the most economical operation, may be determined. Consideration must, however, be given to the possibility of having the material delivered to the elevators without delay so that they may operate at their maximum handling capacity under the given

conditions. Because of the narrow platforms and the material on the platforms and the distance the elevator may be from the loading point of the truck, and the amount of space required to maneuver the trucks and trailers, there is usually considerable difficulty in delivering the material to the elevators so that they can perform at the maximum handling capacity rate and in this case it is necessary to multiply the handling capacity of the elevator by some factor less than one, the value of which will depend on the local arrangements.

The time for loading and unloading trucks will, of course, depend on the kind of trucks and the facilities for getting them on and off the elevators. Where the elevator has an opening at both ends and trailers are used, then the truck can pass directly across the platform carrying on the trailers which would be uncoupled in the proper location. If the elevators accommodate two trailers in tandem, this time allowance may be fairly closely determined and should be about 15 seconds. If there is another set of trucks, side by side, then it is doubtful if the two sets will be carried on simultaneously.

In unloading, it must be taken into account whether all trucks are unloaded at one level, or whether they are unloaded at different levels and the same applies to loading. The running time may be averaged after having determined the average number of stops in a trip.

Time must be allowed for the operation of doors and gates and the time required will depend not only on the types of doors and gates used, but also on whether it is permissible to have these doors and gates moving while the elevator is coming to, or leaving the landing, or whether, as would generally be the case in railway terminals, it is necessary to wait until the doors and gates are completely closed before the elevator can start and to wait until the elevator is either level with the landing or practically so, before doors and gates can be opened. Interlocks should, of course, be provided so that it is impossible to open doors or gates except when the car is stopped at the corresponding landing.

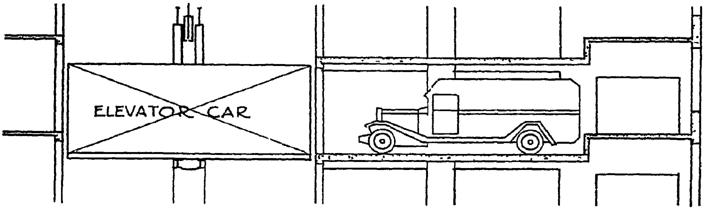
Buildings for combined storage and manufacturing purposes connected with railways are now being erected to a considerable extent and these are now being provided with large elevators for the purpose of carrying loaded automobile trucks from and to the various levels. Sub-levels are provided so that a truck, after driving off the elevator, is adjacent to a platform which is at the tail-board level. This type of construction is illustrated in Fig. II and III and is covered by patent rights. An example of such large truck elevators is, 30,000 lb. capacity at 175 F.P.M. having a platform 10 ft. 3 in. by 30 ft., used in a building ten stories high. These automobile truck elevators are supplemented by other freight and passenger elevators.

In some cases, platforms are made to accommodate two automobiles side by side or end for end, or sometimes four automobiles, two side by side and two end for end.

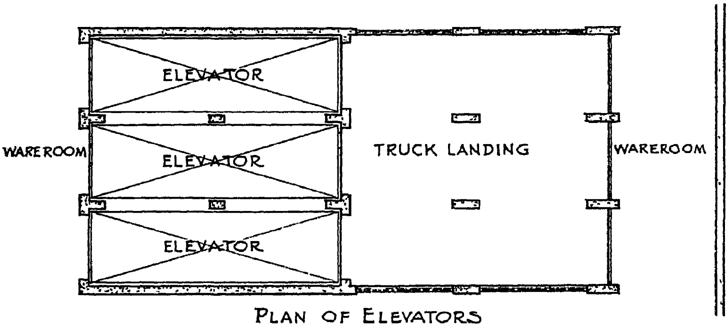
The speeds of elevators for handling freight should, of course, be higher with the longer runs. High speeds are advantageous when the time of loading and unloading is short and when the elevators can be worked steadily. If the elevators must stand at landings for a considerable length of time, there is no particular advantage in having high speeds.

In some large storage warehouses of seven stories height, 12,000 lb. capacity elevators are being used which have a speed of 125 F.P.M. Ap-

proximately 40,000 square feet of storage space has been allowed per elevator in some of these installations.



LONGITUDINAL SECTION THROUGH ELEVATOR
FIG II



PLAN OF ELEVATORS
FIG. III

In other seven-story buildings where the storage operation is by hand trucks, a speed of 100 F.P.M. has been employed, using 6,000 lb. capacity elevators serving as much as 45,000 sq. ft. of storage space. In some ten-story warehouses, elevator speeds of 200 F.P.M. have been employed. The amount of tonnage that may be handled in a given time depends on the length of the run, the number of stops made, the methods of loading and unloading and whether or not the operation can be such that the material is always available for loading without delay and can be immediately unloaded without delay. It also, of course, depends on the bulk of the material, which, however, may be reasonably averaged, allowing a proper margin. Data is developed in Table III showing the time required to run various distances with elevators of different speeds. An average time for operating doors and gates and an average time for loading and unloading by trailer system and for automobile trucks and hand trucks is shown in Table IV. From this data, the maximum possible handling capacity may be determined by assuming average runs with average number of stops and adding time for door operation and loading and unloading, thus determining the round-trip time and the number of trucks handled. Assuming an average tonnage for these trucks, the total tonnage handled in a given time may readily be computed.

TABLE III

TIME TO RUN VARIOUS DISTANCES (in seconds)

Distance in Feet	*100 F.P.M. Elevator*	*125 F.P.M. Elevator*	*150 F.P.M. Elevator*	*175 F.P.M. Elevator*	*200 F.P.M. Elevator*
10	7.4	6.3	5.6	5.1	4.8
20	13.4	11.1	9.6	8.5	7.8
30	19.4	15.9	13.6	11.9	10.8
40	25.4	20.7	17.6	15.3	13.8
50	31.4	25.5	21.6	18.7	16.8
60	37.4	30.3	25.6	22.1	19.8
70	43.4	35.1	29.6	25.5	22.8
80	49.4	39.9	33.6	28.9	25.8
90	55.4	44.7	37.6	32.3	28.8
100	61.4	49.5	41.6	35.7	31.8
110	67.4	54.3	45.6	39.1	34.8
120	73.4	59.1	49.6	42.5	37.8
130	79.4	63.9	53.6	45.9	40.8
140	85.4	68.7	57.6	49.3	43.8
150	91.4	73.5	61.6	52.7	46.8

TABLE IV

DOOR OPERATING TIME

1. Average Time for Power Operated Vertical Bi-parting Door, Opening and Closing (assuming door operation synchronized with micro operation which is typical) = 7.0 Sec.
2. Average Time for Hand Operated Vertical Bi-parting Door, Opening and Closing (this includes an average allowance for operator to walk from car switch to position for operating door). = 22.0 Sec.
3.* Average Time for a Folding Car Gate, Opening and Closing. = 3.0 Sec.

*NOTE: Freight car may or may not have a gate depending on local regulations. If used for combined passenger and freight service a car gate generally is required. Automobile lifts usually do not have a car gate.

LOADING AND UNLOADING TIME

1. Average Time for an Automobile Truck to Run on to an Elevator = 15.0 Sec.
2. Average Time for an Automoblie Truck to Run off an Elevator = 15.0 Sec.
3. Average Time to Run 4 Hand Trucks on to an Empty Elevator = 40.0 Sec.
4. Average Time to Run 4 Hand Trucks off an Elevator = 40.0 Sec.
5. Average Time to Run 4 Trailer Trucks (group of two coupled together and pulled by 2 separate engines) on to an Empty Elevator = 30.0 Sec.
6. Average Time to Run 4 Trailer Trucks (groups of two coupled together and pulled by 2 separate engines) off an elevator = 30.0 Sec.

EXAMPLES OF ROUND TRIP TIME OF FREIGHT ELEVATORS IN STORAGE WAREHOUSES

1. Automobile Truck Elevator—Duty 30,000 lb. at 175 F.P.M. Self-Leveling with Power Operated Bi-parting Hatch Doors—No gate on Car—Opening at 12 floors—Rise 154 ft. Cycle of Operation Assumed as follows:

Elevator receives truck at ground floor, carries truck to 8th floor, where it is discharged, reverses at 8th floor, picks up another truck at 4th floor, carries this truck to ground floor, this completing the round trip.

Truck Run On at Ground Floor	=	15.0 Sec.
Run from Grd. to 8th Floor (98 ft.)	=	35.0 Sec.
Truck Run Off at 8th Floor	=	15.0 Sec.
Run from 8th to 4th Floor (56 ft.)	=	20.7 Sec.
Truck to Run On at 4th Floor	=	15.0 Sec.
Run from 4th to Grd. Floor (42 ft.)	=	16.0 Sec.
Truck Run Off at Grd. Floor	=	15.0 Sec.
3 Door Operations at 7.0 Sec.	=	21.0 Sec.
Net Round Trip Time	=	152.7 Sec.

2. Freight Elevator—Duty 6,000 lb. at 125 F.P.M. Self-Leveling with Hand Operated Bi-parting Hatch Doors—Gate on Car—Opening at 7 floors—Rise 84 ft. Cycle of Operation assumed as follows:

Elevator receives 4 Hand Trucks at ground floor, carries them to 5th floor where they are discharged, reverses at 5th floor and returns to ground floor completing the round trip.

4 Hand Trucks Run On at Ground Floor	=	40.0 Sec.
Run from Grd. to 5th Floor	=	28.4 Sec.
4 Hand Trucks Run Off at 5th Floor	=	40.0 Sec.
Run from 5th to Grd. Floor	=	28.4 Sec.
2 Door and Gate Openings at (22.0+3.0)	=	50.0 Sec.
Net Round Trip Time	=	186.8 Sec.

In determining the number of elevators required, the peak tonnage of arrival and departure must be determined and the elevators must be based on this peak period making allowance for percentage of maximum handling capacity that can be obtained in consideration of the local condition.

The arrangement of elevators also depends on local conditions. Evidently from an elevator standpoint, the minimum number of elevators is required if the elevators are centralized and if there are arrangements that will permit them to be worked close to maximum capacity rate in the peak period. It is found, however, that in many cases, such centralization of elevators is impossible and that it is necessary to locate elevators along a platform often in single units considerably separated. In this case, observations have generally shown that these elevators are not worked nearly at maximum capacity even in peak periods.

In order to determine the percentage of maximum capacity that can be allowed in the peak period, it is necessary to form a definite scheme of handling the material, taking into account the traffic lanes that can be allowed and the system of checking the material and also the kind of trucks used.

In some cases, freight elevators are grouped in pairs. This is in accordance with a tendency toward centralization and the assumption that when so located they will actually handle in the peaks, a higher percentage of their maximum handling capacity than would be the case if they were grouped in single units.

The size of freight elevator cars is generally dependent on the size and number of trucks to be handled. In most cases they are arranged to handle a single automobile truck or two or four trailer trucks, or four hand trucks. Typical car sizes are shown in Table V. The capacity of the elevator in relation to its platform area cannot be definitely fixed. In some cases the

minimum capacity must be equal to the requirements on the basis of passenger loading, which would be 75 to 100 lb. per square foot of net inside platform area and in other cases, the laws permit platforms based on as low as 50 lb. per square foot of loading. The capacity must be prominently displayed on the elevator car. If freight elevators are to be used for carrying passengers, they must conform to all the safety requirements affecting passenger elevators and are limited in number of passengers to the load capacity divided by 150 lb.

TABLE V

TYPICAL FREIGHT CAR PLATFORM SIZES

Kind of Elevator	*Rated Load (Lb.)*	*Platform Dimensions (Outside)*
Automobile Lift	30,000	10 ft. 3 in. by 30 ft. 0 in.
Automobile Lift	12,000	9 ft. 4 in. by 22 ft. 2 in.
Freight	10,000	9 ft. 3 in. by 18 ft. 3 in.
Freight	6,000	9 ft. 0 in. by 12 ft. 6 in.

Elevators may be built with platforms of any required size. The large platforms generally go with freight elevators and the speeds of freight elevators are not usually very high because the rises are limited and there is considerable time required for loading and unloading in many cases. Passenger elevators are operated at speeds of 50 to 1200 F.P.M., high speeds being used for high office buildings, for example, 1200 F.P.M. for the high rise express elevators in buildings 60 to 80 stories high. In intensive service office buildings, the elevator speeds generally run from about 700 F.P.M. for the lower rise group to 1200 F.P.M. for the high rise group and the load capacity from 2500 lb. to 3500 lb. In some comparatively low office buildings, speeds of 350 to 500 F.P.M. are employed and such speeds are also used for elevators handling railway passengers, where there is a sufficient rise.

Conveyors

In some cases freight is handled between two levels by chain conveyors operating on inclines so arranged that a man trucking with a two-wheel hand truck can hook this to cleats on the chain and move up and down with the load. This type of apparatus is in use on docks principally, and has been found advantageous for low rises.

Types of Elevators

At the present time, practically all elevators are electric and they are almost entirely of the traction type. Previous to the introduction of the traction type elevator, hydraulic elevators were used to a considerable extent but they may now be considered obsolete except in the case of very short rises with limited space conditions and so located that the cables and electric apparatus could not be readily protected. Under these conditions, plunger type hydraulic elevators are still installed to a limited extent. The hydraulic elevator is less safe than the electric elevator of the traction type, particularly because of the difficulty of providing proper interlocks with hydraulic eleva-

tors for the purpose of preventing accidents at landings, due to the movement of the car with doors or gates open.

The electric elevator is also less expensive than the hydraulic elevator and requires less maintenance and may be conveniently attached to a source of electric supply in any location. The electric elevator is also particularly adapted to automatic operation which is now in general use.

The drum type electric elevator, where the hoisting cables are wound on and off a spiral drum is now practically obsolete. This type of elevator has the objection of the horizontal movement of the ropes across the drum and particularly the danger of car or counterweight being carried into contact with the overhead work, sometimes resulting in ropes being pulled out, in which case the mechanical safety would be the only means of stopping the car.

The traction type elevator has practically eliminated the danger of ropes giving way or pulling out of their fastenings. With this type of elevator, several cables in parallel pass from the car over a grooved friction driving sheave and thence to the counterweight. When either the car or counterweight rests on the buffers at the lower end of their travel, the release of this weight from the cables will permit the traction sheave to rotate without further motion of car or counterweight since there is not sufficient traction between the cables and the grooved friction driving sheave to lift the unbalanced load.

There are two types of traction elevators known as the "double wrap" traction and the "single wrap" traction. In the case of the double wrap, the grooves of the traction sheave are round and the ropes passing up from the car pass once over the traction sheave and then down and about half around an idler sheave and then up and again over the traction sheave between the ropes of the first wrap and finally pass down to the counterweight. With the single wrap, the hoisting cables pass up from the car over a pinch groove traction sheave and then down to the counterweight. The approved type of pinch groove is a round groove, relieved in the bottom by a channel, so that the rope rests against the round sides of the groove and is free at the bottom. This type of sheave has the advantage over the "V" groove in that the rope always has a proper bearing surface and the traction remains practically constant. The single wrap is generally used for elevator speeds below 400 F.P.M. and the double wrap for speeds above 400 F.P.M.

The hoist ropes are balanced by counterbalance ropes which pass from the bottom of the car down and around a floating sheave which moves in guides located in the pit and carries a certain amount of tension weight, the ropes passing up from this sheave and attaching to the bottom of the counterweight. In all cases, the car and counterweight move in steel Tee-rail guides.

Elevator Machines

Elevator machines are of the geared or gearless type, the latter being used for speeds of 300 F.P.M. and above, and the former being used for slow speeds, below 300 F.P.M. and in some cases up to 400 F.P.M. or somewhat more. The gearless elevator, as its name implies, does not have gears used for reducing speed between the driving motor and the traction sheave. For speeds of 600 F.P.M. and over, the gearless elevator rope drive is as described above, while for slower speeds, rope gearing is employed, giving a ratio usually of 2:1 between driving sheave speed and car speed and sometimes 3:1

and 4:1. This rope gearing is of the usual type, by idler sheaves on car and counterweight and idler sheaves located above the hoisting.

Gearless elevators have the advantage of employing a very slow speed motor usually from 60 to about 140 R.P.M. The traction driving sheave is carried directly on the armature shaft as is also the brake drum. These motors are all direct current as the alternating current motor is unfitted to this application.

Geared elevators usually employ a worm gear reduction between the motor and the traction sheave shaft. In addition to this, in some cases, there is a spur gear reduction and sometimes rope gearing for very slow speeds. Elevator machines of this type are operated either by direct current motors or by induction motors having resistance type squirrel cage rotors.

For speeds above 150 to 200 F.P.M., the induction motors are of the so-called 2-speed type provided with stator windings having two different numbers of poles, the slow speed usually being about 1/3 of the rated speed. For the lower speeds, single speed induction motors are used.

The motors used with geared elevators usually run at from 600 to 900 R.P.M.

Methods of Elevator Control

Slow speed elevators are usually operated by rheostatic control and the higher speed elevators are now generally operated by voltage control, which requires a motor generator set for each elevator. This set runs at practically constant speed and may be driven either by a direct current or by an alternating current motor of the practically constant speed type. It furnishes a means of controlling the speed of the elevator machine by multi-voltages, ranging between zero and a suitable limiting voltage upon which the elevator motor runs at full speed. With this type of control, acceleration and retardation of the elevator are inherently smooth and the speed regulation is very good within the entire range of load of the elevator. Another advantage of this control is that it is equally well adapted to alternating or direct current supply and the performance of the elevator on either type of supply is excellent. This control is used for practically all medium and high speed elevators where the service is intensive. It is particularly adapted to automatic elevators. Automatic control features are used to some extent in practically all elevator operation. The control switches are usually of the magnet type and except for the lower speeds, the control operation during acceleration and retardation is automatic.

Automatic leveling is generally in use for busy freight elevators and for high speed passenger elevators. This automatic feature insures that the elevator will be stopped level with the landing and will be maintained level while passengers or freight are passing on and off the elevator. This automatic leveling is obtained independently of the main control and is controlled by some type of cams in hatchway or penthouse which, when the elevator is brought close to the landing at slow speed by the main control, automatically bring it up to, or back to, the landing. Automatic leveling should always operate in both directions as it is only by this means that the elevator may be maintained level with the landing as the stretch of the hoisting cables change, due to changing load on the elevator platform.

In some cases, the elevator machines are provided with an auxiliary drive for leveling, in addition to the main drive. This additional auxiliary drive is operated by a separate motor and gearing and moves the elevator at about 10 per cent of the speed of the main drive during the leveling. In other cases, there is no auxiliary drive and the main elevator motor is regulated by means of voltage control so as to perform the leveling operation.

A leveling zone is provided, extending a short distance on either side of each landing and the operation is such that the elevator, having been slowed down by the main control and brought at slow speed into this micro zone, the leveling controller brings the elevator to the landing and stops it level with the landing. This feature is particularly advantageous for freight elevators where the material is handled on trucks, since the elevator platform is maintained level with the landing sill as the truck wheels pass on and off the platform. Self-leveling is also very desirable for passenger elevators, particularly in intensive service, as it brings the elevator to the landing without any unnecessary delay or inconvenience to passengers and by maintaining the level, avoids the tripping hazard and permits passengers to pass on and off the car at relatively high speed, since they do not have to watch their step.

Operating Devices for Elevators

Push buttons are now being largely used to control the movement of elevators. Full automatic types of push button elevators are available, arranged so that by pressing a button in the hall, the car will automatically come to the landing and stop and after entering the car and pressing the button, the doors will automatically close and the elevator automatically proceed to the corresponding landing when the doors will automatically open. Some controls are arranged so that the elevators stop for any intermediate calls and others so that the elevator is entirely in control of the person who has it until their transportation has been completed, after which it is available for the next service.

Automatic elevators automatically park at suitable landings and are called from them by the operation of the hall push buttons.

Another type of automatic elevator control that is now in almost universal use in large office buildings provides an attendant in the car who initiates the closing of the doors and presses the car buttons in response to the directions of passengers. These elevators make a full trip, making all stops as designated by the hall and car buttons that have been momentarily pressed. At each stop, after the passenger transfer has been completed, the attendant initiates the door and gate closing, after which the doors and gates close automatically and when they are closed and the hatchway door is locked, the elevator proceeds automatically to the next landing where the service calls it and makes a level landing, the doors and gates opening automatically.

The usual Up and Down push buttons are provided in the halls for calling the elevator but with this type, the momentary pressure of these hall buttons sets an automatic stop for the first elevator in the group approaching the landing in the required direction.

Car Switch Operation

With this type of operation, the operator in the car controls the starting and slowing down and stopping of the elevator. The method of directing

the stops is by means of a separate signal system operated by the hall buttons. The car stops are made in answer to the directions of passengers. Automatic leveling may be provided with car switch operation. This type of elevator, while fairly satisfactory for slow and medium speeds, is much inferior to the automatic system previously described for high speeds. With the so-called "car switch" operation, which is really manual operation, the service is largely dependent upon the skill and diligence of the operator, while with the automatic type, no skill of operation is required and it is very easy to provide service of practically 100 per cent efficiency and anyone of reasonable intelligence can operate the elevator satisfactorily.

Application of Various Types of Elevators

Automatic elevator operation is used for high speed intensive service with an attendant in the car and for medium and slow speed elevators, when the elevators are operated by the passengers or by handlers of freight.

The automatic signal control elevator is now generally used for modern office buildings.

Elevators operated by car switch are used for smaller buildings and for freight service. So-called "self-service" automatic elevators are used for more or less intermittent service to avoid the expense of operators on the car.

Gearless traction elevators are used in practically every case for speeds over 500 F.P.M. and with 2:1 roping are now being used for speeds of from 300 to 500 F.P.M. Worm geared elevators are used for speeds of 100 to, in some cases, as high as 400 F.P.M. for small buildings and for handling freight.

Self-leveling elevators are used in high speed passenger service and in freight service, particularly where trucks are used for carrying the freight.

Self-leveling and automatic elevators are largely of the unit multi-voltage control type and in this case they are leveled by the regular elevator motor.

The auxiliary motor micro, or self-leveling device, is used for medium speed elevators. If the elevators are of the type using alternating current elevator motors, the auxiliary leveling device is generally used.

Safety Devices

All elevators are provided with normal and final terminal stopping devices. The normal device automatically slows down the elevator and stops it either at, or close to the terminal landing, but permits the elevator to be run in the opposite direction by operating the regular controlling device. This normal device generally works by means of a switch on the car operated by cams in the hatchway.

In case the normal device should fail, then the car, after proceeding a short distance beyond the landing, operates switches located in the hatchway, which cut off all power and apply all braking devices.

Just beyond the terminal levels, the car and counterweight strike the buffers. Except for very slow speed elevators which use spring buffers, the buffers are of the oil type and have a stroke equal to that required for gravity retardation from governor tripping speed.

At the limit of their travels, the car and counterweight bottom and the traction is released.

Mechanical safeties are also provided on the cars which operate on overspeed in the down direction, the jaws coming into contact with the rails and thus stopping and holding the car. On overspeed in either direction, before the mechanical safety is called upon to act, the governor device which operates the safety cuts off all power and applied all brakes, obtaining a quick stop. A safety switch is provided in all elevator cars which also functions to cut off all power and apply all brakes. Both the governor safety switch and the car safety switch generally open the power supply by the operation of two magnet switches, either one of which will cut off the power and apply the brakes.

High speed elevators are now generally arranged so that the tension device which operates on guides in the pit, cannot be pulled up, though it is free to move down to provide the tension. With this arrangement, the car and counterweight are tied together at all times and neither can jump under any condition of operation. This device also greatly improves the operation of the mechanical safeties in that the retardation is much more constant from no load to full load in the car than is the case where it is possible for car and counterweight to jump.

Traction elevators are generally counterbalanced so that the counterweight weighs from 40 to 42½ per cent of the load capacity more than the empty car. Except for very short rises, the hoisting cables are balanced by counterbalance cables passing from the bottom of the car around the floating sheave in the pit and up to the bottom of the counterweight. The flexible cables carrying the electric conductors to the car, are attached to the middle of the hatchway and hang in a loop from there to the bottom of the car.

For some slow and medium speed elevators of comparatively short rises, counterbalance chains are used, looped in the same way as the conductor cables.

Doors and Gates for Elevators

It is now the usual practice to provide solid flush doors for hatchway openings and also for automatic, and especially for high speed elevators, solid flush doors on the cars. In many cases, the doors slide horizontally. For freight elevators, vertical sliding doors are frequently provided for hatchway openings with two panels, one moving up and one down. Sliding or collapsible gates are used on some elevators.

Doors and gates are so arranged that they must be closed before the elevator can start and while it is running, except that they may be opened at the landing where the elevator is stopped if it is within a few inches of the landing and is leveling at slow speed toward the landing. Hatchway doors are usually provided with interlocks which lock the doors mechanically except when the car is stopping practically at the landing. Cab doors or gates are provided with contacts without mechanical locks.

Doors on the cars have an advantage for high speed elevators in that they may be operated rapidly and there is no danger of passengers or operators getting their fingers caught. They also have a psychological advantage since the passengers are not affected by the speed of movement of the car. The acceleration and retardation are nearly the same for high and medium speed elevators so that the passenger is no more inconvenienced with elevators operating at 1200 F.P.M. than at 600 F.P.M., or even less.

Elevator doors and gates are now frequently power operated, either by electric or pneumatic power. The most modern elevators have the doors opened by an electric motor drive and closed by spring pressure and the mechanism is provided with hydraulic checks in both directions. For the usual office building passenger cars with power operation, center opening doors with two panels moving in opposite directions are most satisfactory and the best width of opening in many cases is 3 ft. 6 in. Such quickly operated doors, with a single motor and gearing on the car for operating all doors, require only a combined opening and closing time of slightly more than two seconds. Large freight elevator doors, when power operated, may require about 3 to 4 seconds in each direction for their movement. Manually operated doors are generally of the two-panel, so-called "two-speed" type with both panels moving in the same direction, one at twice the speed of the other. Manual operators of the toggle type are generally used and these have springs for closing and are provided with checks. Considerable time is saved by power operation of passenger elevator doors and the labor of the operator of the car is considerably reduced.

Office Buildings

Such buildings are elevatored on the basis of the expected five-minute peaks in the morning when filling the building and during the luncheon period. The elevators are suitably grouped to give a satisfactory interval of time between elevators available to a passenger. In the modern high office building, there are a number of groups serving various zones, some local to the lower floors and other express to connecting floors and serving thence a number of floors locally.

In elevatoring these buildings, typical round-trip times are set up in the peaks and the number of passengers that each elevator can handle in five minutes is determined. If the expected five-minute traffic is known, then the number of elevators is determined. The five-minute peaks will vary from 11 to 35 per cent of the population, depending on the expected occupancy.

An example of a large office building which is immediately connected to a railway terminal is one having about one million square feet of net rentable area and a height of thirty-one stories. This is a rented office building and is efficiently served by thirty-two automatic signal control elevators in four groups of eight each. These elevators are capable of a speed of 800 F.P.M. Three of these groups are express and one local and they each serve their complement of the floors of the building.

Each building must be elevatored according to its individual requirements and a large amount of data is necessary both as to the performance of the elevators and the probable traffic peaks. The elevatoring of such buildings is a matter for traffic experts and it is not within the province of this paper to attempt to go into these details. The highest building in the world and the largest office building is now being erected. This building will be 85 stories high and is expected to have about 20,000 inhabitants. It is entirely elevatored by automatic signal control elevators, of which there are seven groups, the total number being sixty-six. The high rise elevators in this building are capable of a speed of 1200 F.P.M.

At the present time, it is possible to determine closely the traffic handling capacity of elevators of any type. Naturally, the automatic elevators will have the maximum traffic handling capacity in a given time. It is also pos-

sible to closely determine the requirements as expressed by the maximum five-minute peaks of traffic that the elevators will be expected to handle. There are certain typical types of buildings in typical locations which can be analyzed on a general basis of requirements. There are numerous other buildings, particularly those used for special purposes and housing certain types of business, which requires a careful study of the particular business to determine the expected traffic peaks. In some of these buildings, it has been found desirable to stagger arrival and departure so as to reduce the elevator requirements.

Escalators may be used for serving some of the lower floors in large buildings.

The employment of double-decked elevators and two elevators operating in the same hatchway may be resorted to in very high buildings.

Both elevators and escalators are now in a high state of development and suitable apparatus is available to meet practically any requirement. Elevators of the highest speeds are very safe and comfortable to ride in. Buildings one hundred stories in height will, no doubt, soon be erected and the gearless traction elevator is adaptable to any height of building that is likely to be erected.

REPORT OF COMMITTEE XXV—RIVERS AND HARBORS

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Committee.

To the American Railway Engineering Association:

Your Committee respectfully presents herewith its report on the subjects assigned as follows:

1. Definition of Terms.
2. Methods for protection against river bank erosion.
3. Types of construction for levees and river dikes for flood protection, giving consideration to stream alignment, sub-surface, soil or other local conditions.
4. Specifications covering the various types of river bank protection and levees in common use.
5. Various types of dredges and their respective uses.
6. Specifications for dredging.
7. Silt deposits in fresh water rivers at the meeting point with brackish waters, also the effect of slight salinity on such deposits.
8. Results of deepening channels on the salinity of rivers and estuaries.
9. Different types of bulkheads, jetties and sea walls, giving cross-sectional description of each and the purpose which they serve.
10. Different types of fender systems protecting bridges, piers and docks.
11. Different types of docks, warehouse piers, coal and ore piers and describe their sizes and uses collaborating with Committee XIV—Yards and Terminals.
12. Size and depth of slips assigned to vessel berths at the various types of docks, warehouse piers, coal and ore piers, collaborating with Committee XIV—Yards and Terminals.

Action Recommended

1. That report of Sub-Committee on Definitions be accepted as information and the subject continued.

2 and 3. That subjects be continued with instructions to report any new developments.

4. That specifications for levee construction submitted to the Convention of 1930 (pp. 1346-1350, Vol. 31) be adopted and approved for printing in the Manual. Also that specifications submitted herewith be received as information and the subject continued.

Bulletin 334, February, 1931.

5. That report on the various types of dredges and their respective uses be adopted and approved for printing in the Manual and the subject discontinued.

6. That specifications for dredging be adopted, approved for printing in the Manual and the subject discontinued.

7 and 8. That the reports be accepted as information and the subjects discontinued.

9, 10, 11 and 12. Committee reports progress and recommends continuance of the subjects with the added instruction to report on maintenance cost and service life of the various structures.

Respectfully submitted,

COMMITTEE ON RIVERS AND HARBORS,

WM. G. ATWOOD, *Chairman.*

Appendix A

(A) RIVERS

E. A. Hadley, Chairman, Sub-Committee; F. W. Alexander, G. J. Bell, A. F. Blaess, W. G. Brown, H. A. Dixon, K. B. Duncan, B. Elkind, F. G. Jonah, A. M. Shaw, J. R. Watt, C. E. Weaver, W. P. Wiltsee.

Your Committee respectfully presents herewith report covering the following subjects:

(1) DEFINITIONS OF TERMS

This subject is handled by a separate Sub-Committee, consisting of: W. C. Swartout, Chairman; W. J. Backes, G. J. Bell, W. G. Brown, H. A. Dixon, R. E. Fristoe, R. J. Middleton, A. M. Shaw, J. R. Watt.

This was understood to mean terms used in construction and maintenance, both Rivers and Harbors.

Definitions are submitted this year as information and with the hope that the Committee may receive comments and criticisms during the ensuing year and may also receive lists of words and terms which the membership may think it would be desirable to include. The Committee will give further study to all definitions with the view of improving and clarifying them before asking that they be included in the Manual.

ANCHORAGE.—That portion of a harbor in which ships are permitted to lie at anchor.

APRON.—That portion of a wharf or pier lying between the waterfront edge and the shed. Strictly speaking, from the viewpoint of construction, that portion of the wharf carried on piles beyond the solid fill.

APRON TRACK.—Railroad tracks along the waterfront edge of a wharf or pier designed for direct transfer of cargo between ship and car.

BALLAST.—Stone placed on any wood mattress to sink it and to make it conform to the river bed.

BAR.—A bar of earth or sand in the river channel projecting above water.

BANK, CONCAVE.—The concave bank of a river has the center of the curve toward the channel.

BANK, CONVEX.—The convex bank of a river has the center of the curve away from the channel.

BANK, SLOUGHING.—Same effect as caving but usually occurs when bank or an underlying stratum is saturated.

BANQUETTE.—Additional embankment or shoulder on land side of levee with top surface on slope 1 to 10 and 1 to 4 so that line of saturation will intersect ground under the level. The line of saturation slopes down from water line at an angle of about 12 degrees and would pass out of the land side slope above the ground when a levee with side slope of 1 to 3 reached a certain height.

BASIN.—A large slip or dock partially surrounded by quays. A tidal dock for berthing ships alongside quays, subject to the fluctuations of water level of the main body of water.

BATTER PILE.—A pile driven at an angle to take up the lateral thrust of an engineering structure.

BEACH.—A portion of shore line whereon sand has been deposited in a fairly level manner.

BREAKWATER.—An engineering structure to afford shelter from wave action; also called mole, jetty.

BRUSH, MATTRESS.—Any live wood growth (preferably willow), main stem one inch to three inches diameter at butt.

BULKHEAD LINE.—Boundary set by state or municipal authorities or U.S. Army engineers beyond which solid fill may not be extended. This rule is subject to modifications.

CANE.—Used to construct small revetment where levee is sloughing. A jointed wood growth of the grass family; grows extensively in the South, 20 to 30 feet high.

CHANNEL.—The buoyed, dredged and policed fairway through which ships proceed from the open sea to their berths or from one berth to another within a harbor.

CHUTE.—A narrow back channel on one side of an island.

CRADLE.—A bridge supported on car wheels, running on an inclined track, for the transfer of railroad cars to river boats at different elevations of water level.

CREVASSE.—A breach in the levee or river embankment.

DEAD MEN.—An anchorage for a guy, cable, etc., consisting of a timber or piece of structural steel buried in the ground with the end of the guy line fastened around its middle.

DIKE.—A structure of earth, stone or timber, erected as a barrier to check, deflect or stop river currents. Sometimes incorrectly used as synonym for a levee—a bank to prevent inundations.

DIKE, MUD CELL, BRUSH.—A honeycomb structure woven with brush with vertical cells six to eight feet square. A mud cell dike may be 60 to 100 feet wide, with length determined by length of bank to be built out. A most effective method on a concave bend to build the bank into the stream.

DIKE, PERMEABLE PILE.—Same as Pile Hurdle.

DIKE, PILE HURDLE.—Clusters of two to four piles, driven alternately to right and left of center line of dike. Top of clusters about at high water. Clusters tied to horizontal pile about five feet below top.

DIKE, SPUR.—A dike extending out from shore to (1) deflect river current, or (2) induce silting and formation of sand bars. In case of (2) steel and wire entanglements are effective on heavy silt bearing shallow streams with high velocities.

DREDGE.—A machine for excavating material at the bottom of a body of water, raising it to the top and discharging it on the bank, or into a scow for removal to a distant point.

DREDGE SPUDS.—Vertical timbers at the corners which, when driven into the bottom by gears, hold the dredge in place.

DREDGE WORK, OVERDEPTH.—Dredging to depth greater than immediately required. Amount determined by type of dredge, amount and rapidity of silting and economy of longer intervals between maintenance dredging.

Dredge Work, Place Measurement.—Excavation measured by sounding before and after removal of materials.

Dredge Work, Scow Factor.—Ratio between cubic contents of scow level full and actual cubic yards in scow. This ratio varies for material, locality and dredging method.

Dredge Work, Scow Measurement.—Excavation measured by taking number of scow loads and assumed cubic yards in scow.

Erosion.—The washing and carrying away of earthen materials by natural processes of water.

Fascine.—A round bundle of brush from one to three feet in diameter and ten to twenty feet long.

Fingers.—Inclined guides on barge on which a mattress is woven and down which it slides to water surface.

Furrowed.—Loosening surface of natural soil of foundation of levee to minimize seepage or tendency of levee to slide on its base where built on a slope or where an enlargement is made to an existing levee.

Impervious Earth.—Material through which water moves slowly and with difficulty.

Island.—A bar covered with cottonwood and other timber.

Jetty.—An engineering structure at the mouth of a river or harbor, or elsewhere, to control the waterflow and currents, to maintain depth of channel, to protect harbor or beach.

Levee.—An embankment or wall to prevent inundation.

Levee, Back of.—Side away from river.

Levee Core Wall.—A wall of selected, impervious material about five feet thick, placed in levee where material within reasonable distance is generally unsuitable.

Levee Crown.—Top of levee; is level perpendicular to center line.

Levee, Front of.—Side next to river.

Levee, Hydraulic Fill.—A levee in which the material is transported and deposited in place by means of water pumped through a pipe line.

Levee, Overtopping.—Flood height exceeds elevation of top of levee.

Levee, Topping.—Temporary work to raise level of top of levee. Done only in emergencies.

Levee, Sand Boil.—Ebulition of water behind levees, fed by channel through or under levee, generally latter.

Levee Section.—Cross-section of levee, perpendicular to center line.

Levee Slope.—Slope or inclination of sides of levee downward from crown. Generally these slopes are 1 to 3 but occasionally are flatter where less suitable materials are available.

Line of Saturation.—Line across a levee up to which water will theoretically saturate the material. This line slopes down from water line on an angle of about 12 degrees in a levee well constructed of good average material.

Mattress, Board.—Mattress woven with boards, alternately headers and stretchers.

Mattress, Concrete.—Mattress of reinforced concrete slabs. Slabs generally overlap and connect. In first mattress of connecting slabs, they were 11 feet by 6 feet by 4 inches, now slabs are 4 feet by one foot by 3 inches.

Mattress, Willow, Basket Woven.—Brush (preferably willow) woven similar to chip basket with selvage of roll fascine bound to mattress by wires.

Mattress, Willow, Brush and Weaving Pole.—Brush laid normal to river bank with poles parallel. Poles on top and bottom tied together by wires.

Mattress, Willow, Pole and Fascine.—Brush bound together in bundles or fascines one to two feet diameter and laid normal to river bank between poles which are tied together by wire or twisted wire strand.

MATTRESS, WILLOW, BRUSH AND WIRE ENVELOP.—Brush laid in two layers between square mesh netting. Bottom of netting envelop parallel to bank, top normal to bank. Bottom brush layer normal to bank, top parallel.

MUCK DITCH.—A ditch 4 to 6 feet wide and 6 feet deep excavated in natural soil along crown center line to explore foundation conditions where character of material is not fully known or where there is a possibility that water will move between natural surface and bottom of levee, and backfilled with puddled or tamped impervious material.

PERVIOUS STRATIFICATION.—Chiefly found in hydraulic fills. A stratum of boulders or gravel extending across fill of varying degrees of porosity.

PIER.—A vertical support of an engineering structure. A wharf running at an angle with the shore line of the body of water, providing a landing place on both sides for vessels to receive and discharge cargo, passengers, stores or fuel.

PIER HEAD LINE, U.S.—Line set by local port authority or U.S. Army engineers beyond which the pier may not extend.

POROUS EARTH.—Material through which water moves quickly and readily.

REEF.—A bar of earth or sand in the river channel under water.

RETARDS, CURRENT.—Full size trees laid parallel and bound together at trunk end by cables. Shore end is anchored to bank midway of a mattress about 300 feet long, with retard normal to bank and extending into stream any desired length. Offshore end is anchored to patented concrete piles sunk below river bed by jetting and driving.

RIPRAP.—Pieces of stone, approximately cubical shape, weighing from 25 to 100 lbs., of a stone which will not disintegrate under alternate exposure to air and water.

RIVER OR WATER GAGE.—A gage graduated in feet and tenths to give elevation of water surface, with zero below extreme low water and extending above extreme high water.

SEA LEVEL, MEAN.—The average height of the sea, determined by averaging the hourly heights of the tide for a period of time depending on the accuracy desired.

SEAWALL.—A barrier along the shore line to prevent encroachment of the sea by direct wave action.

SEDIMENT.—Earthen material carried by a stream in suspension.

SEEPAGE.—Water passing through or under a levee or dam from the higher to lower side.

SEEP WATER.—Water which has passed through or under a levee or dam.

SILTING.—When the suspended matter, or silt, in a stream is in excess of the sedimentary transporting power of the current the suspended excess is dropped.

SLIP.—Open space or tidal dock between piers.

In a restricted sense, referring to ferries only, a slip is a water space protected by racks on both sides and sufficient only for the accommodation of one vessel.

SOUNDINGS.—Measurement of depth of water, giving elevation of under water land surfaces.

SPUD.—A device used for anchoring a dredge or other floating craft to the bottom or bank of a body of water. The usual form consists of a vertical timber sliding in guides attached outside the scow side, or in a well formed within the hull.

THALWEG (from German).—The buried channel of a river: The natural course of a river bed, from hills to the sea.

TIDE LEVEL, MEAN.—The average of the high waters and the low waters taken over a considerable period of time.

TOWHEAD.—A bar covered with a grassy growth of young willows.

WAVE WASH, LEVEE.—Erosion caused by waves due to high winds across large areas of water during flood periods.

WHARF.—A berthing place for vessels to facilitate direct loading and discharge.

(2) METHODS FOR PROTECTION AGAINST RIVER BANK EROSION

The Committee has nothing further to add at this time to the information submitted in its last year's report.

(3) TYPES OF CONSTRUCTION FOR LEVEES AND RIVER DIKES FOR FLOOD PROTECTION, GIVING CONSIDERATION TO STREAM ALIGNMENT, SUB-SURFACE, SOIL OR OTHER LOCAL CONDITIONS

The Committee has nothing further to add at this time to the information submitted in its last year's report.

(4) SPECIFICATIONS COVERING THE SEVERAL TYPES OF RIVER BANK PROTECTION AND LEVEES IN COMMON USE

Your Committee submits for consideration the following specifications:

General Statement of Work
Loose Fascine Type Mattress
Board Mattress
Mud Cells
Rip Rap Bank Paving
Anchor Piling

Action Recommended

(1) It is recommended that the report on definitions of terms be accepted as information.

(2) It is recommended that the report on methods for protection against river bank erosion be continued as an open subject to the end that future developments in the art may be investigated and reported upon by your committee.

(3) It is recommended that the report on types of construction for levees and river dikes for flood protection be continued as an open subject to the end that future developments in the art may be investigated and reported upon by your committee.

(4) It is recommended that specifications for levees submitted with last year's report as Appendix A-c be accepted and approved for printing in the Manual, and the specifications herewith submitted be accepted as information and the subject continued.

GENERAL STATEMENT OF WORK

ELEVATIONS AND STAGES

All elevations in these specifications refer to ....

Water's edge or low water stage, wherever referred to in these specifications, shall be taken as a stage of..........................in the U.S. Weather Bureau gage located at ....

Extent of Work

Character of Work

Bank Grading

The bank, where directed and in advance of any paving, is to be graded from water's edge to a line at the top of bank as located by the Engineer. Bank is to be graded to slope of one (1) foot vertical to two (2) feet horizontal, unless otherwise directed.

All stumps shall be removed to a depth of eighteen (18) inches below the finished surface and the holes shall be backfilled and well tamped. The graded slope shall have a smooth and even surface; all holes and depressions are to be filled and well tamped.

SPECIFICATIONS FOR LOOSE FASCINE TYPE MATTRESS

All mattress of "Loose Fascine" type shall be composed of compacted brush and poles. Work shall begin at such point as may be directed by the Engineer, and shall be constructed continuously downstream terminating at such location and in such manner as may be directed by the Engineer.

If, for any reason, mattress must be made in more than one section, the lap of one section over another shall be not less than twenty (20) feet. Mattress shall not be made in more than one section without sanction of the Engineer.

In beginning each mattress, a head is to be built by splicing and binding together poles and brush to make a compact fascine about eighteen (18) inches in diameter and of length equal to the specified width of the proposed mattress, the inner edge of which shall be at water's edge, or as may be directed by the Engineer.

Bottom poles running parallel to the length of mattress shall be inserted in the head, and the ends securely spiked and bound to the poles forming the head. The inner line of bottom poles shall be laid on the slope of bank at water's edge and the succeeding lines, placed at intervals of approximately eight (8) feet to the outer edge of the mattress, parallel with the inner line.

The poles may be of any variety of live, straight, sound timber, not less than twenty (20) feet in length nor less than four (4) inches in diameter at small end. The poles in each line shall lap not less than four (4) feet and be securely spiked and bound together with two lashings of number nine (9) wire doubled, the points of splicing to be so located as not to come opposite splices in adjoining lines.

Any variety of live, straight brush, in lengths of sixteen (16) feet or more, and not exceeding four (4) inches in diameter at butt end, may be used. The brush shall be placed on bottom poles at right angles thereto, in beds or fascines about four (4) feet wide and of such depth as will give a thickness of fourteen (14) inches when bound, and shall be bound at intervals coinciding with each bottom pole with two lines of galvanized cable called longitudinal "Sewing Cables" alternating from top to bottom of the successive beds or fascines of brush.

The sewing cables shall be standard 5/16 inch galvanized wire cable having a tensile strength of not less than 5000 lb. After filling each fascine, the brush shall be drawn back tightly against previous fascine by pulling on lower or bottom cable after it is brought up around the brush, and on top cable after it is drawn down over the brush and around the bottom pole. When brush is drawn to a compact bundle, the top cable shall be secured to the bottom pole by means of a staple of length sufficient to give a tight bind.

Lateral cables, consisting of single lines of one-half (½) inch galvanized wire cable shall be run across and through the mattress thirty (30) feet apart. Each cable shall be securely fastened by binding and clamping to outer and inner weaving poles, and have a turn around each intermediate weaving pole.

Each lateral cable shall extend up the slope and be securely fastened to a "dead man" placed eight (8) feet, or more where required, back from the top of slope, and four (4) feet below the surface of ground.

The "dead men" shall be of any variety sound timber acceptable to the Engineer, six (6) inches in diameter, if round, or of equal cross-section if square, and five (5) feet in length. The holes for the "dead men" shall be backfilled and well tamped and sufficient excess earth left on top to allow for settlement. To reach the "dead men" the lateral cables shall be passed through trenches which shall afterwards be filled and well tamped.

The head of the mattress and every section of mattress shall be secured by a sufficient number of one-half (½) inch galvanized wire cables fastened to head fascine and longitudinal cables which shall be run ashore to "dead men" placed fifty (50) feet or more back from edge of bank, the cables to form a forty-five (45) degree angle with the head of the mattress

All splices and hitches in cables shall be made with square knots.

Top poles called binders, running in rows longitudinally the length of mattress shall be placed on top of brush over each alternate bottom pole, and be securely bound thereto every eight (8) feet with bindings alternating with a single five-sixteenths (5/16) inch galvanized cable and double strands of number nine (9) galvanized wire. Cross poles shall be placed on top of binders spaced sixteen (16) feet centers and be securely bound to binders with double strands of number nine (9) galvanized wire at each intersection. Top poles of binders, and cross poles, shall be of same dimensions as bottom poles, and may be of any variety of live straight sound timber.

The mattress shall be ballasted with "one-man stone" of good quality, such as will not disintegrate under action of air or water. The stone shall be in pieces weighing an average of approximately one hundred (100) pounds, and no piece shall weigh less than twenty-five (25) pounds, nor more than one hundred and fifty (150) pounds. Three-quarters (¾) cubic yard of stone shall be used to the "square" (100 square feet) of mattress. The stone shall be uniformly distributed over the mattress. The cost of the stone and the placing of same shall be included in the price to be paid for constructing the mattress.

SPECIFICATIONS FOR BOARD MATTRESS

All mattress which is to be constructed of the "Board" or Lumber type is to be composed of interwoven boards. The starting point or beginning of the mattress shall be as designated and it shall be constructed continuously downstream terminating at such point and in such manner as may be directed by the Engineer. The inner edge of the mattress is to be placed at low water elevation, or as directed by the Engineer.

If for any reason the mattress must be constructed in more than one section, the lap of one section over another shall be not less than fifteen (15) feet. No laps shall be made in the mattress without the sanction of the Engineer.

The boards composing the mattress are to be of green gum, oak, or pine lumber of good quality acceptable to the Engineer of size 1″ x 6″ and of mixed lengths from 12 feet to 16 feet.

All logs, snags, stumps, trees and other obstructions that will prevent the mattress from lying evenly and in contact with the river bed shall be removed by the Contractor before construction of the mattress is begun. This shall be included in the cost per square foot of the mattress. After all of the obstructions have been removed the mattress is to be constructed in the following manner and in accordance with the accompanying plan.

Header

In beginning each mattress, a header is to be built up by first laying across and parallel to the matt or launching barge and at right angles to the bank, 3 thicknesses of 1″ x 6″ boards to form the bottom half of the header block, breaking joints not less than 3 feet. These boards shall be securely nailed together with 10d wire nails and a lashing of one turn of two strands of No. 9 galvanized wire every 3 feet along the entire length of the lower part of the header.

Weavers

On top of the bottom half of the header and at right angles thereto and running parallel with the mattress, 6″ boards hereafter called weavers shall be laid and spaced, 4′ 6″ apart. The ends of the weavers shall be securely fastened to the bottom half of the header by nailing with 3-10d galvanized wire nails and lashing with one turn of two strands of No. 9 galvanized wire. All weavers are to be made continuous throughout the length of the mattress by lap splicing, splices shall lap not less than 3 feet and shall be fastened securely by nailing along the lap with 6-10d wire nails, and lashing securely with one turn of two strands of No. 9 galvanized wire at each end of the lap. The points of splices to be so located as not to come opposite to splices in adjoining weavers.

The top half of the header shall be made similar to the bottom half, shall be placed on top of the weavers directly over the bottom half of the header and breaking joints with it. The whole shall be securely fastened together with nails of suitable length and at each intersection with a weaver, the top and bottom half of the header is to be securely bolted together with one ¾″ machine bolt fitted with two washers. The entire bottom and top halves of the header are to be fastened securely together at four foot six inches (4′ 6″) intervals along the entire length of the header by lashing with one turn of 5/16″ galvanized wire cable.

Transverse Planks

Transverse planks shall be woven alternately over and under the weavers at right angles thereto and parallel with the header in courses shoved down over the weavers and spaced not more than 1″ apart. The transverse planks shall be made continuous throughout the width of the mattress by splicing one plank with another, the lap splice to be not less than 3 feet. Each splice shall be secured by not less than 4 nails, and lashed securely with one turn of two strands of No. 9 galvanized iron wire at each end of the lap. The points of splicing in the transverse planks shall be made so as not to come opposite the splices in adjoining lines. Each plank at each intersection with a weaver shall be fastened to the weaver with two nails and to the outer or riverward weaver with four nails. No plank shall project beyond the outside or inside weaver, and all projections shall be cut off flush with the outside of the weaver.

Binders

Binders running parallel with the length and on top of the mattress shall be built as follows:

Along the outer weaver a built up binder 5″ in height consisting of 3 lines of 1″ x 6″ boards separated by 1″ x 6″ x 6″ blocks spaced 24 inches center to center shall be placed. Over each alternate weaver from the outer weaver a built up binder 3 inches in height, consisting of two lines of 1″ x 6″ boards and separated by 1″ x 6″ x 6″ blocks spaced 24″ center to center shall be placed. On the remaining weavers a single line of 1″ x 6″ boards shall be placed and all binders shall be securely nailed together and shall be bound to the weavers at 8 foot intervals along their entire length with one turn of ¼″ galvanized wire cable, except the outside or riverward binder, which binder shall be securely bound to the weaver with one turn of 5/16″ galvanized cable at eight foot (8) intervals along the entire length of the binder.

Cross Planks

At intervals of 20 feet throughout the mattress, and at right angles to the weaver and parallel to the header, a single line of 1″ x 6″ boards shall be laid across the mattress. These boards shall be securely nailed and bound to the weavers and binders with one turn of ¼″ galvanized cable.

The lower or downstream end of the mattress shall be finished with a selvage similar to the upstream and using nails and ¾″ machine bolts fitted with suitable washers and 5/16″ galvanized wire cable.

After the mattress has been launched, all wire lashing shall be tightened, and all weavers, top poles, top binders, and woven boards that have been broken shall be repaired before mattress is ballasted.

Anchor Cables

The head of the mattress and every section of mattress shall be secured by a sufficient number of one-half (½) inch galvanized wire cables fastened to the head of the mattress and longitudinal cables, and run ashore and anchored to dead men placed 50 feet back from the top of the bank. Anchor cables are to be placed on the bank so as to form a 45 degree angle or less with the head of the mattress.

Longitudinal Cables

Longitudinal cables of 5/16″ galvanized wire cable fastened to the head of mattress and to the anchor cables, and spaced 9 feet apart, across the entire width of the mattress, shall be run continuously throughout the entire length of mattress. Each cable shall be twined along its weaver and top plank, drawn taut and clamped to the weaver and top plank at each turn with a galvanized iron staple.

Lateral Cables

Lateral cables consisting of single lines of one half (½) inch galvanized wire cable shall be run across and through the width of the mattress at right angles to the weaver and shall be spaced 40 feet apart. Each cable shall have a turn around each weaver except the inner and outer weaver, at which it shall have two turns and shall be secured with two clamps. Each one-half inch (½) lateral cable shall head up the bank and be anchored to a "dead man" placed not less than 5 feet back from the top of the bank. Each alternate cable shall be of five-sixteenths (5/16) inch galvanized wire cable and shall be run across and through the mattress from the outer to the inner weaver, and shall be evenly spaced between the ½ inch lateral cables. Each 5/16″ cable shall have a turn around each weaver except the inner and outer weaver at which it shall have two turns and shall be securely clamped.

Replacing Broken Boards and Wire Lashings

After launching and before sinking the mattress, all boards that have become broken shall be replaced, and all cables and wire lashings tightened and put in a satisfactory condition.

Ballasting Mattress

All mattresses shall be properly sunk to the bed of the river by being evenly weighted with one-man stone of good quality that will not disintegrate under the action of air or water. The stone shall be in pieces weighing on an average about 75 pounds to the piece, no pieces to weigh less than 50 pounds nor more than 100 pounds. A minimum of one-half (½) cubic yard of stone shall be used to the square (100 square feet), or more stone shall be used if required, to insure the mattress coming in good contact with the bed of the river at all points. Great care must be exercised in order to prevent the mattress being broken or damaged in sinking and stone should not be dropped or thrown on the mattress with sufficient force to break or injure the boards in the body of the mattress. The cost of the stone and the distributing of same shall be included in the price to be paid for constructing the mattress.

Deadmen

Deadmen shall be of any variety good sound timber acceptable to the Engineer. Deadmen shall be of diameter not less than 10 inches if round and of 10″ x 10″ cross-section if square and shall be not less than 5 feet in length. The holes for deadmen shall be excavated to a depth not less than 4 feet below ground surface. To reach deadmen, lateral cables shall be passed

through trenches, which shall be backfilled and well tamped. Holes for "deadmen" shall be backfilled and well tamped and sufficient excess earth left on top to allow for settlement.

Material

All wire used shall be No. 9 soft galvanized wire.

All wire cable shall be ¼ inch, 5/16 inch and ½ inch galvanized wire cable having a tensile strength of approximately 5000 lb.

All nails shall be 10d galvanized wire nails.

All bolts shall be ¾ inch machine bolts fitted with two suitable washers.

The connection between cables shall be secured with clamps made from good commercial iron free from flaws or defects.

All splices and hitches made in cables shall be made with square knots.

It is the spirit and intent of these specifications to secure for the Railroad Company a substantial and complete installation. Contractor must at all times have on the work sufficient equipment and labor to properly carry out the work in a satisfactory manner and without avoidable delays.

SPECIFICATIONS FOR MUD CELLS

The mud cells, located on the foundation mattress, shall be made of poles and brush, made up into cells or cribs eight (8) feet square, with a total height above top of mattress as may be directed by the Engineer. The cells shall be built on the mattress at such location and in such manner as directed.

Poles and Brush

The poles and brush composing the mud cells shall be live straight willow or other timber acceptable to the Engineer and of following sizes:

Poles shall be from fifteen (15) to thirty (30) feet in length, and not less than three (3) inches in diameter at the tip and, or more than eight (8) inches in diameter at the butt end.

Brush shall not be less than twelve (12) feet in length, and not exceeding three (3) inches in diameter at the butt end.

Construction of Mud Cells

In beginning the mud cells, poles of the size specified above shall be laid on the mattress parallel with its length and spaced eight (8) feet centers. These poles shall be the length of the proposed mud cells.

The poles in these rows shall lap not less than four (4) feet and splices shall be made with two lashings of No. 9 wire doubled at each end of the lap. All lines of bottom poles shall be secured to each row of longitudinal sewing cables of the mattress by means of 5/16 inch galvanized wire cable. After the bottom poles have been laid and securely bound to the mattress cross poles alternating with bundles of brush and longitudinal poles alternating with brush shall be laid successively so as to form cells eight (8) feet square and the work shall be continued in this manner until the mud cells are completed. The poles and brush used in forming the cells shall be laid so as to interlock with those of each adjacent cell, so that the lap in any line of poles shall not come opposite to the lap in any adjoining line. In building the cells, cross poles shall be laid so as to project eight (8) feet to form the outside cell in the next row, and longitudinal poles shall project from the downstream side of each row of cells, a distance of twelve (12) feet so as to interlock and tie into the cells in adjoining rows. After each set of cells have been carried to full height, each intersection of the longitudinal and cross poles shall be tied with a single line of 5/16 inch galvanized wire cable passed under the sewing cables of the mattress and up over, and around the top layer of poles or brush and twisted so that no movement of the brush or poles in the cells will occur.

A layer of brush approximately six (6) inches in thickness shall be distributed uniformly over the top of the mud cells to form a decking over them. The brush shall be lapped not less than four (4) feet at points of splicing

and shall be bound to the top poles of the mud cells at each intersection of the longitudinal and cross poles, and at points midway between the intersections with double strands of No. 9 galvanized wire. Top poles laid over the top poles of the cells shall then be laid over the decking and bound every four (4) feet with double No. 9 wire ties. After the decking has been placed as specified above, the cells shall be ballasted as specified below.

Ballast consisting of "one-man" stone, of good quality, such as will not disintegrate under action of air or water, shall then be placed close together along the top poles of the decking so as to hold the brush firmly in place. The stone shall be in pieces weighing on the average approximately one hundred (100) pounds and no piece shall weigh less than twenty-five (25) pounds, nor more than one hundred and fifty (150) pounds. Three quarters (¾) of a cubic yard of ballast shall be used to the "square" (100 square feet) of decking. During the construction of the mud cells, a single line of one-half (½) inch anchor cable shall be attached to the mud cells at a point midway between the top and bottom, and shall be run ashore to "dead men" placed as specified under "mattress construction." The anchor cables shall have a turn around longitudinal poles and each succeeding line of inside poles of the mud cells.

SPECIFICATIONS FOR RIPRAP BANK PAVING

Paving Stone

The paving stone shall be of one-man stone of good quality such as will not disintegrate under the action of air or water. The stone shall be in pieces approximately rectangular in cross-section and shall weigh an average of one hundred (100) pounds per piece, no piece to weigh less than twenty-five (25) pounds nor more than one hundred and fifty (150) pounds.

Cast Paving

Wherever directed by the Engineer the upper or inner portion of the mattress from the low water's edge or inner edge of the mattress to a point ten (10) feet out onto the mattress shall be paved by casting paving stone. The stone shall be placed in such manner as to completely cover the surface, and cast paving shall have a minimum thickness of ten (10) inches. Cast paving shall be paid for the same as slope paving.

Slope Paving

Wherever directed and previous to paving the slope, the space just above the shore or inner edge of the mattress shall be filled with spalls or small stones flush with the top of the mattress, and running out to no depth four (4) feet up the slope, so as to fair out the surface in advance of the paving. The cost of spalling or filling shall be paid for as extra rock per cubic yard.

The slope paving shall commence at the bottom of the slope at low water's edge and progress upward to a line at or near the top of the slope as may be directed by the Engineer. Each stone shall be placed by hand and firmly bedded. Paving stone shall be so placed as to completely cover the surface of the slope, whenever paving stone is of such shape as will not permit the stone to come in good contact with the surface of slope and other stones, the voids or holes under and between the stones shall be filled with spalls or small stones in such manner so as to secure even and tight paving.

The depth of paving normal to slope and measured from the top of finished slope, shall be eight (8) inches at the upper edge of paving at the top of slope, and twelve (12) inches at the bottom of the slope at low water's edge, given an average depth of ten (10) inches measured from the top of the finished grade to the upper surface of the paving.

After paving stone has been placed and before final acceptance is given, the voids in the paving are to be filled with spalls or small stones, in order to secure a comparatively smooth and unbroken surface. The cost of such spalling is to be included in the cost of the paving.

SPECIFICATIONS FOR ANCHOR PILING

A line of piling shall be driven along the bank as a means of anchoring the mattress and for support of the embankment.

(The piles used for this work should meet that portion of the requirements under "Specifications for Timber Piles" which appears on page 469 of the Manual issued in 1929, which will insure sufficient length of life of piling to accomplish the purpose for which they are driven.)

Piles shall be driven plumb to a penetration of not less than 15 feet on a line to be designated by the Engineer, and shall be placed approximately 12 feet center to center. Previous to completion of the work, the piles shall be sawed off at an elevation to be designated by the Engineer.

Appendix B

HARBORS

W. L. Morse, Chairman, Sub-Committee; W. J. Backes, E. A. Craft, R. G. Develin, W. E. Hawley, C. R. Howard, G. A. Rodman, E. H. Roth, C. U. Smith, R. C. Young.

Your Committee respectfully presents herewith report covering the following subjects:

(5) Various types of Dredges and their respective uses.

(6) Specifications for Dredging.

(7) Silt deposits in fresh water rivers at the meeting point with brackish waters, also the effect of slight salinity on such deposits.

(8) Results of deepening channels on the salinity of rivers and estuaries.

Action Recommended

(5) That the report on the various types of dredges and their respective uses, as presented by Sub-Committee "B," Appendix B-5, be approved and placed in the Manual;

(6) That the specifications for dredging as presented by Sub-Committee "B," Appendix B-6, be approved and placed in the Manual;

(7) That the report on silt deposits in fresh water rivers at the meeting point with brackish waters, also the effect of slight salinity on such deposits, as presented by Sub-Committee "B," Appendix B-7, be accepted as information and the subject dropped;

(8) That the report on results of deepening channels on the salinity of rivers and estuaries, as presented by Sub-Committee "B," Appendix B-8, be accepted as information and the subject dropped.

Appendix B-5

(5) TYPES OF DREDGES AND THEIR RESPECTIVE USES

Dredges are machines for excavating material from the bottom of a body of water, raising it to the top and dumping it onto banks or into scows for removal to a distant point. They are classified as floating dredges when mounted on scows or other form of vessel, or land dredges when used to travel on land but which excavate from beneath the level on which they stand and generally from beneath the water.

There are two general types of floating dredges, bucket and hydraulic, usually classified as grapple dredge, dipper dredge, ladder dredge and suction dredge.

BUCKET DREDGES

Grapple Dredge

In this type the digging element is a grab bucket operated by ropes.

Dipper Dredge, sometimes called Scoop Dredge

This type has a bottom dumping bucket mounted on a handle and operated from a boom at one end of the scow and is similar to a steam shovel. The machine is very heavy, being supported on spuds while handling material. Considerable time is lost when shifting its position due to adjustments of the spud supports. It can be used in very hard material such as rock or old foundations which is loaded into scows or sometimes deposited on banks alongside the dredge.

Clam Shell

There are two types of this dredge, one for soft material and one for hard material, the latter being equipped with teeth. Clam shell dredges are the most practicable machines for loading silt or soft material into scows which material is usually deposited a considerable distance from the point of removal. They can be used in excavating material from close to a dock.

Orange Peel

This type is very successful in dredging hard material containing debris such as chains, anchors, loose wood, etc., where the dredged material is to be loaded into scows, and can be used in dredging material from close to a dock.

Ladder Dredge

Dredges of this type have an endless chain bucket elevator extending down into the water on a frame or ladder. They deposit the dredged material into discharge hoppers by means of scraper buckets attached to a chain which passes around a vertical frame or ladder with tumblers at each end, being driven from the upper tumbler.

HYDRAULIC DREDGES

Suction Dredge

In this type, excavated material mixed with water is drawn into a centrifugal pump through an intake pipe and deposited onto a bank or into a scow.

It is a practicable machine for removing sand, gravel and in fact almost any class of material that does not contain a large amount of debris. It will not remove material containing pieces of chain, piles, wood, anchors and other similar debris as such will clog the pumps or otherwise obstruct the pipe. This machine is generally used in filling in low lands. If the material to be removed is silt or soft mud, the area filled in will require several years to dry out; therefore, for land fills that should become solidified quickly only sand or gravel should be used.

Sea Going Hopper Dredge

This is a self-propelled hydraulic dredge which dredges the excavated material into bottom dumping hoppers within its own hull and carries it to a dumping ground by its own propelling machinery. This type is especially

developed for work on ocean bars where it can continue dredging long after rising seas would drive other dredges to shelter. It is efficient and economical for harbor work where the material is such as can be pumped (where the cut is 1,000 feet long or more) and where the distance to the point of deposit is too great for pipe line dredges. To deepen a slip or remove a small shoal it has to work at anchor which increases the cost by double or more. It can be used to better advantage in channels where traffic is congested than other types of dredge.

Appendix B-6

(6) DREDGING SPECIFICATIONS

1. The general location and dimensions of the........................ to be dredged are shown in detail on plan or plans marked:

which form a part of these specifications.

Work to Be Done

2. The........................ to be dredged so that................ shall have throughout upon the completion of the work the depth specified over......................whole extent as shown on the plan or plans, with the banks at the sides sloped at an angle not flatter than 1 on 3, unless otherwise specified.

Location

No payment will be made for material dredged outside the specified limits, as shown by the soundings, unless the same is specifically ordered in writing by the Engineer before the excavation is made.

Physical Data

3. Note.—These may include general features affecting the work, such as range of tides, wave action, exposure to storms, unusual currents, duration of usual working season, presence of cables, pipes, or tunnels, bridges across the channel or across the route to the dumping ground, and a reference to the regulations concerning the same.

Bench Marks

4. The plane of reference of.............as used in these specifications is that determined by the following bench marks:

Note.—Give location and description of bench marks and relation to the stated plane of reference.

Traffic

5. Note.—Describe the usual character of traffic in the channel with reference to the effect it may have on contract operations.

Overdepth Dredging

6. In doing the work the Contractor shall make the bottom of the excavation as smooth and level as possible at or slightly below the plane of the required depth, but no payment will be made for any material dredged from more than..................foot or feet below the required depth as determined from information obtained by surveys made under the direction of the Engineer upon the completion of all the work covered in this contract, except that, when the quantity of material excavated is to be determined by place measurement, the soundings made for the various estimates and the removal of shoals shall be conclusive and deductions for overdepth or material excavated outside the specified limits will be based upon the result of these soundings.

Payment will not be made for material taken from beyond the limits above described which will be deducted from the total amount dredged as excessive overdepth dredging.

Side Slopes

7. Material actually removed, within limits approved by the Engineer, to provide for final side slopes not flatter than 1 on 3, unless otherwise specified, but not in excess of the amount lying above this limiting side slope, will be estimated and paid for, whether dredged in original position or after having fallen into the cut. In computing the limiting amount of side slope dredging an overdepth of .... feet, measured vertically will be used.

Payment will not be made for material taken from beyond the limits above described which will be deducted from the total amount dredged as excessive side slope dredging.

Quantity of Material

8. The amount of material to be removed, including the required side slopes at an angle of 1 on 3, unless otherwise specified, exclusive of allowable overdepth, is estimated to be................cubic yards, but this amount shall not control the performance of this contract, and the Contractor shall be bound thereunder whether or not such estimate is approximately correct.

Character of Materials

9 The material to be removed is believed to be...................... ....but bidders are expected to examine the work and decide for themselves as to its character and to make their bids accordingly, as the Railroad does not guarantee the accuracy of this description.

Work Covered by Price Bid

10. The price bid per cubic yard for dredging shall cover the cost of removal and disposition of all material encountered. Material to be classified as ledge rock must be of such composition as, in the opinion of the Engineer shall require blasting or use of special plant for its removal, and shall not include fragments of rock or boulders capable of being removed by the dredge in one piece. Boulders in excess of 5 cubic yards in volume will be considered as ledge.

Method of Measurement

11. (A)—The amount of excavation done will, wherever practicable, be determined by measurements of the dredged material in place, or

(B)—If measured on scows in which it is placed for transportation to the dumping ground the determination of value of work done will be based upon such measurements after deducting the volume, if any, which may be excavated for more than................feet below the required depth and side slopes.

The number of cubic yards of boulders or ledge rock excavated will be determined by measurement made by the Engineer, payment for which will be based upon such measurements.

Scow Measurement

12. The material removed by scows will be measured by the cubic yard in scows at the dredge by the Engineer, but the Contractor will be held responsible for its satisfactory disposal and proper deductions will be made for all material that is not deposited according to the specifications. No scow will be used in the work until the measurements for determining its capacity have been made under the direction of the Engineer, and, if necessary, it must be hauled out or beached for this purpose. Scows will be remeasured without hauling or beaching whenever in the opinion of the Engineer it is expedient.

The Contractor is required to be present in person or to be represented by an authorized agent during the measuring of scows. When the capacities of the scows are determined, or redetermined, a record of allowed capacities will be sent to the Contractor; if he protests within five days the scow will be remeasured at his expense and he must be present in person or be represented by a capable accredited agent, so that correct measurements can be agreed upon. Failure to protest within five days will be considered acceptance of the measurements.

If any alterations are made in any scow it must be inspected and, if necessary, remeasured before again being used in the work. Each scow will be plainly marked by a distinctive number, letter or name which shall not be changed or given to any other scow during the period of the contract.

To insure correct measurements, the pockets shall be filled evenly as far as practicable. The judgment of the Engineer as to whether or not a scow is properly loaded, or to what extent it is short or overloaded, is final unless a protest is made by the Contractor or his duly accredited representative before the scow is moved away from the dredge. In case a protest is made, the contents of the scow shall be leveled off immediately by the Contractor and properly measured to the satisfaction of the Engineer.

Whether or not contract depth is being made will be determined by soundings or sweepings taken behind the dredge as the work progresses and the Contractor will be advised of the results. Should this survey disclose any excess of overdepth or side slope dredging, the amount of such excess will be deducted from the monthly estimates.

Place Measurement

13. The material removed will be measured by the cubic yard in place by means of soundings or sweepings taken before and after dredging. The maps referred to are believed to represent accurately the average existing conditions; but they will be verified and corrected, if necessary, by soundings taken shortly before dredging is begun in any locality. Soundings or sweepings will be made, as far as practicable, of the entire area dredged as the work progresses and so far as practical the contractor will be advised of the results before anchors are shifted. Monthly deductions for excessive overdepth or side slope dredging and monthly payments for approximate net results, will be based upon these surveys.

Final Examination and Acceptance

14. As soon as possible after the completion of the contract the area dredged will be examined thoroughly by soundings and by sweeping, to the extent determined advisable by the Engineer. Should any shoals, lumps or other lack of contract depth be disclosed by this examination the Contractor will be required to remove them unless relieved by orders of the Engineer. If

the bottom is soft and the shoal areas are small and form no material obstruction to navigation, the removal of such shoal may be waived, in the discretion of the Engineer.

The Contractor or his authorized representative will be notified when soundings are to be made, and will be permitted to accompany the sounding party.

Final estimates will be based entirely on the difference between the last soundings made before dredging and the results of the last examination, subject to proper deductions or correction of deductions for excessive overdepth dredging or excessive side slope dredging.

If the material removed has been measured in scows, the final payment will be subject to proper deductions or correction of deductions already made on account of excessive overdepth dredging or excessive side slope dredging.

If the material is to be measured in place the final estimates will be based entirely on the difference between the soundings made before and after dredging and corrected by proper deductions for excessive overdepth or excessive side slope dredging.

Shoaling

15. Should the last examination of the contract work, extended to include the entire area, show shoaling since the work was done or shifting, for which the Contractor is evidently not responsible and which shall include shoals in the finished channel formed by the natural lowering of side slopes, between the time of dredging and that of the last examination herein referred to, redredging at the contract price may be done, if agreeable to both the Contractor and the Engineer.

Order of Work

16. The work is to be carried on at such localities and in such order or procedure as may be found necessary by the Engineer. The location and limits of the work to be done will be plainly indicated by the Engineer by stakes and ranges or otherwise, and gages will be established to show stages of water with reference to the datum plane for dredging. The Contractor may be required to suspend dredging at any time, when, for any reason, the gages and ranges cannot be seen or properly followed.

In order that the Contractor may receive proper payment, the full depth required under the contract must be secured in the whole of the area worked over as the work progresses, unless prevented by ledge rock.

Disposal of Excavated Material

17. The material excavated must be transported and deposited at...... .... The maximum distance to which the material must be transported will not exceed..........................and the average distance will not exceed.......................... The dumping ground must be plainly marked by the Contractor by conspicuous buoys or stakes and no dumping shall be done unless an accredited inspector is present at the time.

In case the material is deposited in confined areas, all embankments or bulkheads needed for confining or grading the material, with necessary waste weirs, must be provided and maintained by the Contractor and the cost thereof shall be included in the price bid.

Provided that a bidder submits with his bid an adequate description of a dumping ground other than that stipulated in these specifications, such deviation as to the place of disposal will be considered in making the award. If, after the award of the contract, a dumping ground other than stipulated in these specifications is proposed, its acceptance will be subject to the approval of the Engineer. In either event the Contractor shall obtain the written consent of the owners of the substituted grounds and furnish evidence thereof to the Engineer before proceeding with the work. All expenses incurred in

connection with providing and making available such dumping grounds shall be borne by the Contractor and all materials deposited thereon and all operations in connection therewith shall be at the Contractor's risk.

In the disposal of dredged material the Contractor will be required to observe all laws and governmental requirements.

Lights

18. If work at night is permitted by the Engineer the Contractor shall maintain, from sunset to sunrise such lights on or about his plant as the Engineer may deem necessary for the proper observation of the dredging operations.

Obstructions

19. The Railroad will not undertake to keep the channel free from vessels or other obstructions, except to the extent of such regulations, if any, as may be prescribed by proper governmental authority. The Contractor will be required to conduct the work in such manner as to obstruct navigation as little as practicable and in case the Contractor's plant so obstructs the channel as to endanger the passage of vessels, said plant shall be promptly moved on the approach of any vessel to such an extent as may be necessary to afford a practicable passage. Upon the completion of the work the Contractor shall promptly remove his plant, including ranges, buoys, piles and other marks placed by him under the contract in navigable waters or on shore.

Inspection

20. The Contractor will be required:

(a) To furnish, on the request of the Engineer, the use of such boats, boatmen, laborers and material forming a part of the ordinary and usual equipment and crew of the dredging plant, as may be reasonably necessary in inspecting and supervising the work.

(b) To furnish, establish and maintain in good order all range marks, stakes, gauges and buoys required for the proper execution of the dredging.

(c) To provide, when required by the Engineer, suitable transportation from all points on shore designated by the Engineer to and from the various pieces of plant and to and from the dumping grounds.

(d) The Contractor shall furnish regularly to inspectors on board the dredge or other craft upon which they are employed, a suitable separate room for office and sleeping purposes if his plant affords room therefor. The room shall be fully equipped and maintained to the satisfaction of the Engineer.

The cost of meeting all of the foregoing requirements shall be included in the price bid.

Plant

21. The plant shall be of sufficient size to meet the requirements of the work and shall be kept, at all times, in condition for efficient work, subject to the inspection and approval of the Engineer.

All scows must be kept in good condition, the coamings kept repaired and the pockets provided with proper doors or appliances to prevent leakage of material.

All pipe lines for hydraulic machines must be kept in good condition at all times, and any leaks or breaks along their length must be promptly and properly repaired.

Appendix B-7

(7) SILT DEPOSITS IN FRESH WATER RIVERS AT THE MEETING POINT WITH BRACKISH WATERS AND THE EFFECT OF SLIGHT SALINITY ON SUCH DEPOSITS

Very little information of any value on this subject has as yet been found. It is a generally accepted fact that salinity does affect deposits of silt. To establish more information on this subject of any value to railroads would require a great deal of study, the resulting value of which is not apparent and it is recommended that the subject be dropped.

Appendix B-8

(8) RESULTS OF DEEPENING CHANNELS ON THE SALINITY OF RIVERS AND ESTUARIES

There is undoubtedly a great deal of information on this subject, but the Committee lacking the funds for a suitable and sufficient investigation of the matter, recommends that the subject be dropped.

Appendix C

(2) HARBOR STRUCTURES

W. H. Kirkbride, Chairman, Sub-Committee; E. A. Craft, K. B. Duncan, B. Elkind, R. E. Fristoe, W. E. Hawley, C. R. Howard, R. J. Middleton, G. A. Rodman, C. U. Smith, C. E. Weaver, W. P. Wiltsee, R. C. Young.

Your Committee has collected a large amount of information bearing on the subjects assigned to it, but has been unable to make a sufficient study of it to permit the preparation of a report. The Sub-Committee therefore, reports progress and recommends the continuance of the subjects.

REPORT OF COMMITTEE X—SIGNALS AND INTERLOCKING

W. M. Post, *Chairman;*
F. D. Beale,
W. E. Boland,
G. H. Dryden,
W. J. Eck,
W. H. Elliott,
G. E. Ellis,
P. M. Gault,
J. V. Hanna,
C. R. Hodgdon,
W. W. Houston,
C. A. Mitchell,
J. C. Mock,
F. W. PflegING, *Vice-Chairman;*
H. G. Morgan,
H. H. Orr,
J. A. Peabody,
A. H. Rudd,
T. S. Stevens,
E. G. Stradling,
C. H. Tillett,
W. M. Vandersluis,
R. C. White,
F. B. Wiegand,
L. Wyant,

Committee.

To the American Railway Engineering Association:

Your Committee respectfully presents herewith report covering the following subjects:

(1) Developments of Automatic Train Control and Cab Signals (Appendix A).

(2) Improvement in Railway Operating Efficiency (Appendix B).

(3) Progress Made in the Use of Modern Railway Signal Systems (Appendix C).

(4) Current Activities of the Signal Section During Past Year (Appendix D).

Action Recommended

(1) That the report in Appendix A be received as information.

(2) That the report in Appendix B be received as information.

(3) That the report in Appendix C be received as information.

(4) That the report in Appendix D be received as information.

Respectfully submitted,
The Committee on Signals and Interlocking,
W. M. Post, *Chairman.*

Appendix A

(1) DEVELOPMENTS OF AUTOMATIC CONTROL AND CAB SIGNALS

G. E. Ellis, Chairman, Sub-Committee.

There has been no change in the situation as regards automatic train control since the last report in Volume 31 of the A.R.E.A. Proceedings, page 1032. All of the devices in service are working in a satisfactory manner.

Bulletin 334, February, 1931.

INTERSTATE COMMERCE COMMISSION ORDERS

No orders have been issued by the Commission. Under date of November 26, 1928, a report was issued on the hearings of the previous spring. This was referred to in the report of the meeting in March, 1929. In that report it was stated that no additional orders for train control would be issued then, but that the matter would be held open for such further orders as may be required. This is a plain intimation that the Commission has not abandoned the thought of train control, although it is clearly inclined to give the carriers an opportunity to make improvements in other lines which each one might think more suitable for its needs. This idea is also brought out in the statement made by S. N. Mills, Assistant Director of the Bureau of Safety, at the September, 1930, meeting of the Signal Section.

Following out the desire expressed by the Commission in its report of November 26, 1928, the Bureau of Railway Economics, co-operating with the Committee on Automatic Train Control, has collected for the years 1928 and 1929 data as to expenditures by the carriers for items particularly relating to safety of operation. These figures were submitted to the Commission and are being used in its annual reports.

Progress

The number of installations remain the same as in the last report, but additional installations not required by the orders have been made by the Richmond, Fredericksburg & Potomac Railroad, extending their installation a short distance on each end. The Boston & Maine Railroad has also equipped the Hoosac Tunnel for operation on both tracks in either direction with the intermittent inductive type, but only the electric engines which pull all trains through the tunnel are equipped. The Southern Pacific Company has installed train control through the snowsheds on the Sierra Nevada Mountains, about 29 miles of road. The joint track used by the Pennsylvania and Baltimore & Ohio Railroads between Newark and Columbus, Ohio, has been equipped so that Pennsylvania engines already equipped with train control will have that protection into Columbus. The Pennsylvania has also equipped a short section of track to connect the West Jersey & Seashore with the Delaware River Bridge Line. The New York, New Haven & Hartford has equipped 14.85 miles of a third track on the second order territory for operation in both directions. Exhibit A shows these additional installations in detail. As there has been no material changes in the major installations it has not been felt necessary to repeat Exhibit A of last year's report.

I.C.C. Inspections

All of the installations have now been inspected by representatives of the Commission and reports printed. Abstracts of those not previously given are included as Exhibit C. The engineers of the Commission are now visiting again the various installations to ascertain the progress made in meeting the exceptions and criticisms embodied in the different reports. It is expected this work will be completed during the present year.

The Committee on Automatic Train Control is working on the problem of interchangeability, and the need for this is illustrated by Exhibit B showing locomotives operating over portions of other lines. In some cases dif-

ferent types are involved and duplicate apparatus is required on the locomotive or track.

Later and more complete data can be secured from the information issued and from the bulletins prepared by the Committee on Automatic Train Control of the American Railway Association.

The cab signal has come into prominence recently, and has been made practical by certain developments in automatic train control devices, particularly of the continuous types. While cab indicators have been known for a considerable period and have been recommended and used abroad, no actual use of them was made in this country until train control was required by the Interstate Commerce Commission in its order of January 10, 1922. Certain test installations used a cab indicator which, however, has not the same significance as the cab signal.

The definitions of the Interstate Commerce Commission, to be used in the preparation of performance reports, are as follows:

> CAB SIGNAL—A device located in the cab which displays an indication of the condition of the controlling section, or of fixed signals in advance.
>
> CAB INDICATOR—A device located in the cab which indicates the condition of one or more elements of the automatic train control apparatus.

The distinction between these two is definite.

While it has been stated above that cab signals were rendered feasible through the development of continuous train control, an intermittent cab indicator is recognized but it does not possess the same advantages as the continuous cab signal. It is felt that if an engineman is to receive a signal indication in the cab it must be subject to constant control through changing conditions on the track, in order not to be misleading, as it might be if of an intermittent character.

Some of the installations made to comply with the orders of the I.C.C. used a cab indicator to indicate when the apparatus had functioned, or to show other conditions as to its operation. A cab signal was installed in connection with installations of the continuous type with the use of wayside signals, and in the case of three carriers, wayside "stop and proceed" signals were not installed or else were removed when the installation was made.

The Interstate Commerce Commission in its order of January 10, 1922, requiring automatic train control, recognized the possibility of establishing a device to control trains without the use of automatic block signals. This implied the use of cab signals, although the type was not specified.

The Pennsylvania Railroad has started the installation of cab signals without the use of the automatic stop feature, but continuing the use of wayside signals. At the present time the territory from Manhattan Transfer to Washington and Altoona to Pittsburgh is so equipped. The installation uses the coder type of continuous control, the same as used on those divisions where the automatic stop is in service. The cab equipment consists of a vertical row of discs through which illuminated series of small circles give an indication similar to that displayed by the signals. Two signals are used, one on each side of the cab, and a loud sounding whistle is employed to attract attention when a change to a more restrictive indication takes place.

This whistle continues to sound until shut off by the engineman, or if he is incapacitated the whistle sounds until it is shut off by the fireman whom it calls to take charge. The Pennsylvania Railroad has installed at the present time on about 807 miles of track, and has equipped 776 engines and 200 multiple unit cars.

Exhibit A

VOLUNTARY INSTALLATIONS OF AUTOMATIC TRAIN CONTROL

SOUTHERN RAILWAY SYSTEM	MILES RD.	MILES TK.
Salisbury to Ashville, N.C. / Biltmore to Hayne, N. C.	205.9	214.1
Charlotte, N.C. to Columbia, S. C.	108.2	108.2
Citico, Tenn. to Macon, Ga.	241.5	282.6
Lot to Holton, Ky. (L&N Tk.)	4.6	4.6
Chattanooga, Tenn. to Meridian, Miss.	294.8	391.8
Macon, Ga. to Jacksonville, Fla.	259.6	265.7
Ashville, N. C. to Knoxville, Tenn. / Bristol to Morristown, Tenn. / Knoxville to Ooltewah, Tenn.	317.6	367.5
Stevenson to Memphis, Tenn.	274.0	281.6
Austell, Ga. to Birmingham, Ala.	148.0	156.5
Meridian, Miss. to New Orleans, La.	191.8	207.7
Haleyville to Jasper, Ala. (Also IC&M&O)	40.6	40.6
TOTAL SOUTHERN SYSTEM	2,086.6	2,320.9
BOSTON & MAINE RR		
Through Hoosac Tunnel (Elec.Engines)	5.1	10.2
SOUTHERN PACIFIC LINES		
Emigrant Gap to Andover, Calif.	29.4	60.2
PENNSYLVANIA RR		
Newark to Columbus, Ohio. (B&O joint tk.)	27.8	72.6
Shore Intl'g., Philadelphia, Pa., to West Haddonfield, N. J.	8.5	17.0

NOTE - Engines are included with those in detailed summary.

NEW YORK CENTRAL SYSTEM	MILES RD.	MILES TK
NEW YORK CENTRAL RR.		
Croton to Rensselaer, N. Y.	107.28	329.08
Syracuse to Buffalo, N. Y.	147.0	579.79
Cleveland, O. to Englewood, Ill.	344.64	1002.58
Rochester to Syspension Bridge, N.Y.	73.33	146.66
TOTAL	672.25	2058.11
MICHIGAN CENTRAL RR.		
Niles, Mich. to Kensington, Ill.	78.47	156.94
N.Y.C. RR - M.C. RR.		
Toledo, Ohio, to Detroit, Mich.	55.01	110.02
BOSTON & ALBANY RR		
Brookline Jct. to Riverside, Mass.	9.25	18.5
TOTAL N.Y.C. SYSTEM	814.98	2,343.57
CHICAGO & NORTH WESTERN RY.		
#Clinton, Iowa, to Chicago, Ill.	155.0	338.0
CENTRAL RR. OF NEW JERSEY		
#Matawan to Atlantic Highlands, N. J.	10.6	10.6
RICHMOND, FRED.& POTOMAC RR		
"NA" Tower to Richmond, and "AF" Tower to Potomac River Bridge	9.0	18.0

#-In operation with cab signals without permissive wayside signals.

VOLUNTARY INSTALLATIONS OF CAB SIGNALS

PENNSYLVANIA RAILROAD	MILES RD.	MILES TK.	ENGINES	M.U.CARS
Manhattan Transfer, N.J. to Philadelphia, Pa.	80.7	332.49		
Philadelphia, Pa. to Washington, D. C.	131.94	475.21	748	63
Pittsburgh to Altoona, Pa.	112.29	464.0	360	
	324.93	1271.70		

NOTE - 12.37 track miles signaled in both directions.

Exhibit B

ROADS OPERATING LOCOMOTIVES OVER PORTIONS OF OTHER LINES EQUIPPED WITH TRAIN CONTROL

OWNING ROAD	TENANT ROAD	ENGINE DEVICE	FROM	TO	ROAD MILES	ENGINES
AC	CRRNJ	Union 3 Speed	Winslow Jct., N.J.	Atlantic City, N. J.	31.0	#
ACL	N&W	General Int.	Petersburg, Va.	Richmond, Va.	22.8	7
ACL	SOUTHERN	General Int.	Selma, N. C.	Rocky Mount, N. C.	41.8	8
B&A	NYC	General Int.	Chatham, N. Y.	North Adams Jct., Mass.	29.0	1
B&O	CRRNJ	Union Int.	Philadelphia, Pa.	Wilsmere, Del.	27.5	10
B&O	READING	Union Int.	Philadelphia, Pa.	Wilsmere, Del.	27.5	16
CRRNJ	PENNA.	Union Stop-Code	Perth Amboy, N. J.	Bay Head, N. J.	37.79	63
C&EI	EJ&E	Miller Ramp	Chicago Heights, Ill.	Jackson, Ind.	144.1	30
C&NW	CB&Q	General 2 Speed	Sterling, Ill.	Agnew, Ill.	5.4	4
CRI&P	M&StL	Regan Ramp	Altoona, Iowa	Des Moines, Iowa	8.7	3
CCC&STL	C&EI	General Int.	Pana, Ill.	Lenox, Ill.	70.6	45*
D&H	NYC	General Int.	Albany, N. Y.	Watervliet, N. Y.	5.6	#
ERIE	NYC	General Int.	Horseheads, N. Y.	Elmira, N. Y.	4.6	3
ERIE	D&H	General Int.	Binghamton, N.Y.	Owego, N. Y.	22.0	10
L&N	CNO&TP	General Int.	Lot, Ky.	Holton, Tenn.	4.6	4
NYC	PENNA.	Union Int.	Girard Jct., Pa.	Erie, Pa.	13.7	38
NYC	PM	General Int.	Porter, Ind.	Pine, Ind.	18.0	#
NYC	PM	General Int.	Alexis, Ohio	Toledo, Ohio	7.44	#
NYC	NYC&STL	Union Int.	71st Street, Chicago, Ill.	63rd Street, Chicago, Ill.	2.0	#
NYC	CCC&STL	General Int.	Berea, Ohio	Cleveland, Ohio	12.0	#
NYC	CCC&STL	General Int.	Indiana Harbor, Ind.	Englewood, Ill.	13.0	#
NYC-MC	CCC&STL	General Int.	Detroit, Mich.	Toledo, Ohio	55.01	#
NYC&STL	C&O	Union Int.	Hammond, Ind.	Stony Island Ave., Chicago, Ill.	9.0	37
N&W	C&O	Union 3 Speed	Glasgow, Va.	Loch Laird, Va.	9.0	4
P&LE	ERIE	Union Int.	Pittsburgh, Pa.	Youngstown, Ohio	64.9	7
P&LE	NYC	General Int.	Pittsburgh, Pa.	Youngstown, Ohio	64.9	#
RF&P	ACL	General Int.	Acca Wye, Va.	James River Bridge, Va.	2.83	#
SOUTHERN	IC	Union Int.	Jasper, Ala.	Haleyville, Ala.	40.3	20
SOUTHERN	M&O	General Int.	Jasper, Ala.	Haleyville, Ala.	40.3	4
SOUTHERN	NOGN	General Int.	Slidell, La.	New Orleans, La.	34.6	15
SOUTHERN	Car.N.W.	General Int.	Newton, N. C.	Hickory, N. C.	9.4	11
STL-SF	M-K-T	National Int.	Nichols, Mo.	Afton, Okla.	111.0	3
						343

*-35 equipped with both Miller Ramp and General Int. control and 10 have General Intermittent only.
#-Engines are included with those listed in detailed summary.

September 13,1930.

Exhibit C

Installation: Long Island Railroad.
Device: Union Switch & Signal Company Continuous Stop—Code.
First Order: H Tower, Long Island City, to Port Washington and Whitestone Landing—8.8 miles single track—12 miles double track.
Second Order: Jamaica to Babylon, N.Y.—27.6 miles double track.
48 locomotives (both steam and electric) and 250 Multiple Unit cars for both orders.

Exceptions: None.

Requirements: As to Maintenance, Inspection and Tests.
Studies should be continued as to the elimination of intermittent changes of cab signal indications both inside of and outside of equipped territory.
Additional protection to be provided at one interlocking.
Lack of uniformity in maintenance at different points should be corrected, and a thorough system of inspection and maintenance should be established to keep equipment in proper operative condition.

Installation: New York, New Haven & Hartford Railroad.
Device: Union Switch & Signal Company Continuous Stop—Code.
Second Order: New Haven, Conn., to Auburn, R.I.—106 miles double track—2.58 miles three track—2.3 miles four track—149 locomotives.
Exceptions: None.
Requirements: As to Maintenance, Inspection and Tests.
Fouling protection and switch-circuit controller used for protection for an open switch are on open-circuit principle.
No cab signal other than the most restrictive should be displayed after passing a stop signal, when the safety of the track is in doubt.
Delayed energization of track circuits with coded current as used at a number of locations, did not at all times function to require acknowledgment at restrictive signals.
Track circuits at certain locations did not initiate an automatic brake application braking distance from a stop signal.
Pneumatic circuit controller designed on open-circuit principle.
Locomotives operating over equipped territory should be given a departure test.
Means were not provided at entrance to train-stop territory to insure device is in operating condition when such locomotives operate over one or more divisions before entering train-stop territory.
Non-equipped locomotives frequently operated in road service over train-stop territory.
Portable test instruments at certain locations did not provide an accurate and complete check of the locomotive equipment.

Installation: Pennsylvania Railroad.
Device: Union Switch & Signal Company Continuous Stop—Code.
First Order: Baltimore, Md., to Harrisburg, Pa.—81.5 miles double track—1095 locomotives interchangeable on all divisions.
Exceptions: None.
Requirements: As to Maintenance, Inspection and Tests.
Studies should be continued until the cause of momentary changes of cab signal near the insulated joints in both clear and occupied blocks has been definitely determined.
Track circuit at one location not long enough to require acknowledgment of restrictive indication when operating at high speed.

Installation: Central Railroad of New Jersey.
Device: Union Switch & Signal Company Continuous Stop—Code.
Second Order: Elizabeth to Bay Head, N.J.—50.1 miles double track—2.0 miles three track—2.0 miles four track—121 locomotives, 49 of which are equipped for operation over first order.

Exceptions: None.

Requirements: As to Maintenance, Inspection and Tests.

At certain interlocking plants should a train pass a home signal in stop position, it might under certain conditions receive a less restrictive cab signal indication.

Shunt fouling and shunting of switch circuit controllers designed on open-circuit principle.

Cut-in loops at entrance to equipped territory are on open-circuit principle.

Pneumatic circuit controller for preventing acknowledgment after an application has begun may fail to operate as intended should the pipe which supplies brake-pipe air pressure to the controller become partially restricted or broken.

Since dispensing with the protection governor the speed governor operates on the open-circuit principle.

Installation: Galveston, Harrisburg & San Antonio Railway (T. & N. O.)

Device: National Safety Appliance Company Intermittent Magnetic Induction.

Second Order: Glidden to San Antonio, Texas—119.91 miles single track—62 locomotives for both orders.

Exceptions: None.

Requirements: As to Maintenance, Inspection and Tests.

The requirements as to maintenance forestalling valve, securing adequate braking distance, and consideration of type of fouling protection at sidings made in the report on the first installation are called to the attention of the carrier.

Appendix B

(2) IMPROVEMENT IN RAILWAY OPERATING EFFICIENCY

W. M. Post, Chairman, Sub-Committee.

The first step in the survey of the situation was a study of the improvement in freight train performance made during the past ten years by the forty-seven railways with annual operating revenues above $25,000,000.

Improvement in Railway Operating Efficiency

The freight train performance of each of the roads was tabulated in terms of gross ton miles, train miles, train hours and gross ton miles per train hour for the years 1920 and 1929 together with the per cent increase or decrease in each of the items.

The roads were divided into three groups on the basis of the ratio of the miles of road equipped with automatic block signaling to the *main* line miles of road. (It is safe to assume that the major part of the automatic block signaling is on the main lines of the roads.)

Group A comprises the roads with a ratio of 60 per cent or more of automatic block miles of road to main line miles of road. This group made the best operating record.

The ratio of the other groups is as follows:

Group B—ratio of 30 to 60 per cent
Group C—ratio of 0 to 30 per cent

The improvement in operating efficiency is clearly shown by the decreases in train miles and train hours and the increases in gross ton miles per train hour made in 1929 as compared with 1920 by each of the three groups, as shown in Table I.

TABLE I

	Per cent*	
	Decrease	*Increase*
Group A (with a ratio of 60 per cent or more of automatic block mileage)		
Gross ton miles		22
Train miles	9	
Train hours	30	
Gross ton miles per train hour		74
Group B (with a ratio of 30 to 60 per cent)		
Gross ton miles		23
Train miles	4	
Train hours	26	
Gross ton miles per train hour		65
Group C (with a ratio of 0 to 30 per cent)		
Gross ton miles		38
Train miles		8
Train hours	14	
Gross ton miles per train hour		60

	Per cent* Decrease	Increase
Average for the three groups		
Gross ton miles		24
Train miles	4	
Train hours	26	
Gross ton miles per train hour		67

* Decrease and increase, 1929 in comparison with 1920.

Chart I is a graphic comparison of the freight train performance of the three groups. The striking feature of the comparison is that although all of the groups show an increase in gross ton miles ranging from 22 to 38 per cent, all of the groups also show a *decrease* in the time required to move this increased freight business, as the train hours decreased 14 to 30 per cent. The net result of the improvement was an increase in gross ton miles per train hour of from 60 to 74 per cent.

TABLE II

Total Miles of Road, Main Line Miles of Road and Automatic Block Miles of Road of the Three Groups

	1919	1920
Group A (with a ratio of 60 per cent or more of automatic block mileage)		
Total miles of road	56,947	53,612
Main line miles of road	26,730	24,900
Automatic block miles of road	22,887	16,852
Ratio of automatic block to main line miles of road	85.6*	67.7*
Group B (with a ratio of 30 to 60 per cent)		
Total miles of road	100,393	98,107
Main line miles of road	57,754	59,181
Automatic block miles of road	25,365	13,545
Ratio of automatic block to main line miles of road	43.9*	22.9*
Group C (with a ratio of 0 to 30 per cent)		
Total miles of road	42,302	40,801
Main line miles of road	29,308	28,260
Automatic block miles of road	5,465	3,829
Ratio of automatic block to main line miles of road	18.6*	13.5*
Average for the three groups		
Total miles of road	199,642	192,520
Main line miles of road	113,792	112,341
Automatic block miles of road	53,717	34,226
Ratio of automatic block to main line miles of road	47.2	30.5

* Group Average.

If the railroads had not improved their performance in 1929 over that of 1920, the train hour expense for 1929 would have been considerably greater than the amount actually paid out. For example, if a train hour has a value of $20, the saving was approximately $275,000,000.

It is not claimed that all of the improvement in operating efficiency is to the credit of automatic block signals as automatic block signaling was only one of the many improvements made by the railways during the past decade.

Capital expenditures of the railways for improvements for the last ten years aggregate nearly $8,000,000,000, covering new equipment, roadway and

structures, additional tracks, heavier rail, car retarders, automatic block signals, centralized traffic control, and other items.

It is, however, claimed that the use of modern signaling systems; automatic block, centralized traffic control for train operation by signals, interlocking, remote power switches and spring switches, all made their contribution to the elimination of train delay and that no small part of the 26 per cent saving in train hours is due to the use of modern railway signaling.

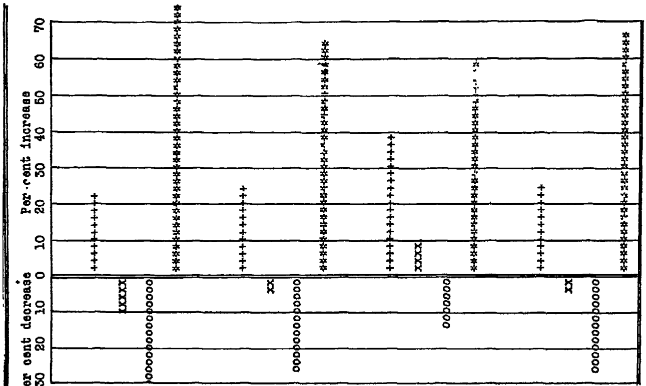
In support of this claim the following by W. J. Cunningham, Professor of Transportation of Harvard University, is of interest:

> "The capacity of a railway may ordinarily be increased substantially by the installation of modern automatic signals. They permit trains to run under closer headway, reduce the number of train stops, and otherwise cut down road delays which have been from 25 per cent to 33 per cent of total time between terminals. * * *"

Chart I - FREIGHT TRAIN PERFORMANCE OF THE FORTY-SEVEN RAILWAYS WITH ANNUAL OPERATING REVENUES ABOVE $25,000,000

Comparison of the freight train performance of the forty-seven roads. The roads are arranged in three groups on the basis of the ratio of the miles of road equipped with automatic block signals to main line miles of road.

	1929	1920	Per cent. dec.	Per cent. inc.
GROUP A - 19 ROADS WITH A.B. RATIO OF 60 to 111 PER CENT				
Gross ton-miles (billions)	380.2	312.9		22
Train-miles (millions)	179.4	198.1	9	
Train-hours (millions)	13.7	19.6	30	
Gross ton-miles per train-hour	27,817	15,943		74
GROUP B - 19 ROADS WITH A.B. RATIO OF 30 to 60 PER CENT				
Gross ton-miles (billions)	482.8	393.5		23
Train-miles (millions)	260.0	271.2	4	
Train-hours (millions)	19.4	26.1	26	
Gross ton-miles per train-hour	24,866	15,063		65
GROUP C - 9 ROADS WITH A.B. RATIO OF 0 to 30 PER CENT				
Gross ton-miles (billions)	144.6	104.9		38
Train-miles (millions)	89.6	83.2		8
Train-hours (millions)	6.6	7.6	14	
Gross ton-miles per train-hour	21,952	13,722		60
GRAND TOTALS AND AVERAGES OF THE THREE GROUPS				
Gross ton-miles (billions)	1,007.7	811.3		24
Train-miles (millions)	529.1	552.6	4	
Train-hours (millions)	39.7	53.4	26	
Gross ton-miles per train-hour	25,399	15,194		67



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Appendix C

(3) PROGRESS MADE IN THE USE OF MODERN RAILWAY SIGNAL SYSTEMS

The progress made in the use of modern railway signaling systems is concisely shown in Chart 2, "Railway Signaling Progress."

	Miles of Road
Item 1—Miles of road operated by Class I Steam Railways, 1928......	240,779

As the traffic density of some 40,000 miles of the above total is not sufficient to warrant modern signaling systems, a conservative estimate of the outlook for automatic block signaling should be based on the forty-seven railways with annual operating revenues above $25,000,000.

Item 2—Miles of road of the forty-seven railways, 1928.............. 199,642

Of this total it has been assumed that at least all of the *main line mileage* should be fully equipped with modern signaling systems.

Item 3—Miles of road, *Main Line,* of the forty-seven railways, 1928 (excludes branches and lines of minor importance).......... 113,792

Item 4—Miles of road of the forty-seven railways equipped with automatic block signals, 1929.............................. 53,717

This represents only the automatic block signal mileage. While the records do not disclose it, the major part of the signaling was installed on the main line mileage.

Item 5—Miles of road equipped, July 1, 1930, for train operation by signal indication on single track lines and in either direction on multiple track lines 2,185

This includes 27 installations of "centralized traffic control," the latest development in directing the movement of trains; a method that promises to supersede directing the movement by train orders and time table superiorities.

Item 6—Miles of road equipped with automatic train stops or train control devices, 1929 11,541

The following is from a statement by S. N. Mills, Assistant Director of the Interstate Commerce Commission Bureau of Safety, September, 1930:

> "* * * The railroads have expended, in round figures, $40,000,000 for train control. We believe that there is a future for train control, that it will grow gradually and normally during the next few years."

Item 7—Miles of road protected by visual cab signals, 1929.......... 3,482

The following is from the annual report of the Director of the Bureau of Safety of the Interstate Commerce Commission, 1929:

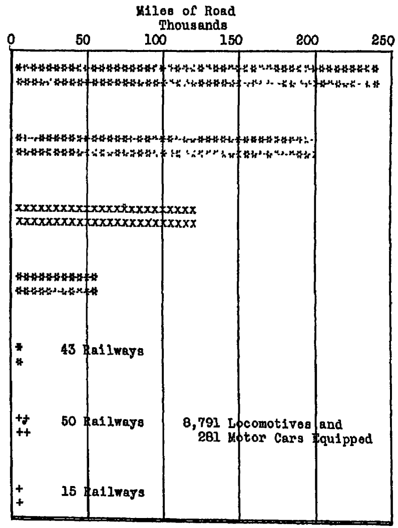
> "Cab signals are without doubt an important development in the art of signaling. They place the signal indication immediately in front of the engineman where it can not be obscured by snow, fog, smoke or other obstructions and where a combination of visible and audible indication is used it is without doubt a valuable addition to the signal system."

Remote power switch machines and car retarders are not included in the chart.

Chart 2 - RAILWAY SIGNALING PROGRESS

Railway Signaling Systems, Class I Railways

		Miles of Road
1	Miles of road operated by Class I Steam Railways Dec. 31, 1928	240,779
2	Miles of road of the forty-seven railways with annual operating revenues above $25,000,000, Dec. 31, 1928	199,642
3	Miles of road, main line, of the forty-seven railways (excludes branches and lines of minor importance), Dec. 31, 1928	113,792
4	Miles of road of the forby-seven railways equipped with automatic block signals, Dec. 31, 1929	53,717
5	Miles of road, Class I Railways, equipped for train operation by signal indication on single track and in either direction on multiple track lines (includes centralized traffic control systems) Dec. 31, 1929	2,185
6	Miles of road, Class I Railways, equipped with automatic train stops or train control devices, Dec. 31, 1929	11,541
7	Miles of road, Class I Railways, protected by visual cab signals, Dec. 31, 1929	3,482



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The above data is based on Interstate Commerce Commission statistics except that Item 5 is based on American Railway Association Signal Section report, 1929, revised to Dec. 31, 1929.

Appendix D

(4) CURRENT ACTIVITIES OF THE SIGNAL SECTION DURING THE PAST YEAR

H. H. Orr, Chairman, Sub-Committee.

Investigations and reports cover the following:

1. Train operation by signal indication.
2. Consolidation of interlockings.
3. Determination of economic value of a remotely controlled switch installation.
4. Operating results obtained by use of automatic block signals replacing manual block on a 58.3 mile double track line.
5. Method of comparing operating results before and after improvement in signal facilities.
6. Installation of car retarder system.
7. Signal protection of spring switches.
8. Centralized traffic control system.
9. Factors which govern in determining the type of interlocking which should be installed. (Revision)
10. Requisites for automatic block signals and manual interlocking.
11. Requisite for protection by signal in emergencies. (Revision)
12. Requisites for take siding indicators, leave siding indicators and switch indicators. (Revision)
13. Development of automatic train control and cab signals.
14. Highway crossing protection:
    (a) Two-direction indications for flashing light signals.
    (b) Shielding lamps from engineman's view.
    (c) Street traffic signals for highways crossing railways.
    (d) Crossing gates.
    (e) Federal and state activities.
15. Track circuits with particular reference to the use of rail motor cars.
16. Table of interlocking units and form for unit distribution. (Revision)
17. Book of Signaling:
    (a) Chapter XVI—Interlocking.
    (b) Chapter XVIII—Electro-pneumatic interlocking.
    (c) Chapter IX—Rectifiers and alternating currents.
18. Instructions for maintenance and testing of signals, interlocking, rectifiers and relays.
19. Definitions of technical terms used in signaling.
20. Guide for allocating train control expenditures.

SPECIFICATIONS REVISED

	Old No.	*New No.*
Electric Interlocking Machine	7619	7630
Mechanical Interlocking Machine, S. & F. Locking	7527	7530
Electro-Mechanical Interlocking Machine	13425	13430
Mechanical Interlocking Machine. Style A Locking	11427	11430
Alternating Current Relay	7819	7830
Track Transformer	8319	8330
Switch Circuit Controller	9520	9530
Bonding	13524	13530
Channel Pin	2312	2330
Aerial Braided Cable	8920	8930
Gray Iron Castings	1611	1630
Malleable Iron Castings	1711	1730
Wrought Iron Bars	1811	1830

SPECIFICATIONS REVISED AND CONSOLIDATED

Fuses	3813 & 9620	9630

NEW SPECIFICATIONS

Alternating Current Power Transfer Relay		14830

REPORT OF COMMITTEE XXI—ECONOMICS OF RAILWAY OPERATION

J. E. Teal, *Chairman;*
B. T. Anderson,
R. C. Bardwell,
A. C. Bradley,
H. F. Burch,
S. B. Cooper,
H. C. Crowell,
W. J. Cunningham,
L. E. Dale,
Olive W. Dennis,
L. F. DeRamus,
W. N. Deramus,
J. H. Dyer,
S. W. Fairweather,
J. M. Farrin,
Z. A. Green,
G. F. Hand,
G. W. Hand,
E. M. Hastings,
E. L. Hoopes,
W. W. Houston,
C. H. R. Howe,
W. W. Judson,
E. E. Kimball,
Shu-T'ien Li,
J. F. Pringle, *Vice-Chairman;*
L. E. Little,
M. F. Mannion,
F. H. McGuigan, Jr.,
P. J. Neff,
O. V. Parsons,
E. S. Pennebaker,
H. T. Porter,
L. S. Rose,
H. Rhoads,
J. E. Saunders,
Mott Sawyer,
R. T. Scholes,
B. J. Schwendt,
S. E. Shoup,
W. P. Sloan,
V. I. Smart,
C. E. Smith,
L. C. Spengler,
C. H. Stein,
M. F. Steinberger,
Barton Wheelwright,
C. C. Williams,
John S. Worley,
Committee.

To the American Railway Engineering Association:

Your Committee respectfully presents herewith report covering the following subjects:

(1) Revision of Manual.

(2) Methods for obtaining a more intensive use of existing railway facilities, with particular reference to securing increased carrying capacity:

(a) Without material additional capital expenditures.

(b) With due regard to reasonable increases in capital expenditures consistent with traffic requirements (Appendix A).

(3) Methods or formulas for the solution of special problems relating to more economical and efficient railway operation (Appendix B).

(4) Most economical makeup of track to carry various traffic densities, collaborating with Committees I—Roadway, II—Ballast, III—Ties, IV—Rail, V—Track and X—Signals and Interlocking.

(5) Suitable units for operating and equipment statistics required by Interstate Commerce Commission to be used on cost comparisons of transportation, equipment and roadway maintenance, with necessary additions thereto, collaborating with Committees XI—Records and Accounts, XVI—Economics of Railway Location, and XXII—Economics of Railway Labor (Appendix C).

(6) Problems of railway operation as affected by the introduction of air transport lines, motor truck and bus lines, with particular reference to the effect of the latter upon branch or feeder lines, collaborating with Committee XIV—Yards and Terminals and with the Motor Transport Division, A.R.A. (Appendix D).

Bulletin 334, February, 1931.

(7) Methods for determining most economical train length, considering all factors entering into transportation costs.

(8) Distribution and utilization of motive power, collaborating with Mechanical Division, A.R.A.

(9) Economies resulting from use of radio telephones for long freight trains and for yard work, collaborating with Committee XIV—Yards and Terminals (Appendix E).

(10) Outline of work for ensuing year.

Action Recommended

Your Committee desires to report progress concerning assignments 1, 4 and 7, and that:

(2) The report of Sub-Committee (Appendix A) be received with the view of having it prepared for presentation and publication in the Manual.

(3) The report of Sub-Committee (Appendix B) be received for publication in the Manual.

(5) The report of Sub-Committee (Appendix C) be received as information and the subject be discontinued.

(6) The report of Sub-Committee (Appendix D) be received as information and the subject be discontinued.

(8) This subject be discontinued.

(9) The report of Sub-Committee (Appendix E) be received as information and the subject be discontinued.

Respectfully submitted,

THE COMMITTEE ON ECONOMICS OF RAILWAY OPERATION,

J. E. TEAL, *Chairman.*

Appendix A

(2) METHOD OF INCREASING THE TRAFFIC CAPACITY OF A RAILWAY

M. F. Mannion, Chairman, Sub-Committee; B. T. Anderson, L. E. Dale, L. F. DeRamus, G. W. Hand, E. M. Hastings, E. L. Hoopes, E. E. Kimball, J. F. Pringle, L. S. Rose, J. E. Saunders, W. P. Sloan, B. J. Schwendt, J. E. Teal.

The traffic capacity of a railway can be increased either by making more intense use of present facilities or by providing new or additional facilities.

(I) STUDY OF RAILROAD OPERATION WITH THE VIEW OF INCREASING ITS CAPACITY WITH ITS EXISTING FACILITIES

In considering the means of increasing the traffic capacity of a railroad, the logical first step is an examination to ascertain:

(A) If the facilities as they exist are being utilized to the maximum capacity.

(B) What changes, if any, in methods of operation will produce increases of capacity.

(C) What minor additions or alterations to facilities can be quickly made which will produce increases of capacity.

Scope

For this examination the engine district—embracing two terminals and the one hundred miles more or less of line between them—is the most suitable unit. If the problem should have to deal with more than one such district, each will have to be examined of itself, and then with the results so obtained they must be studied together, each in its relation to the adjoining districts and to the line as a whole, and thus by progressive study the examination completed for the entire railroad.

It will be seen that the examination must deal largely with the operating organization of the railroad. It must determine if there is intelligent supervision, if there is proper effort on the part of the men in the ranks, if there is co-ordination of the several departments, if a proper esprit de corps pervades the organization; in short, if the performance of the machinery in the hands of the organization is of a high standard of efficiency.

The examination should be started by a preliminary study of the operating conditions on the district. This will to a large degree determine the scope of the more thorough and detailed study which should follow. These studies can best be made by examinations of the movement, locomotive performance and other operating records, the comparison of the current performances with those of former periods, and by consultation with the operating officers having the district in charge.

The preliminary study will probably disclose one of two operating situations.

A

(1) A heavy traffic being moved with comparatively free road and terminal movements, the volume of business handled approximately equaling or exceeding that of prior periods of good performance.

(2) The road movement free and the terminals—one or both congested, or both road and terminals congested, the volume of business moved being less than during former periods of good performance.

Congestion and Embargoes

The first case is one requiring very careful study and mature consideration before steps are taken looking to increasing the capacity by changes in the methods of operating the district. When a heavy traffic is being moved it is logical that the number of cars in yards will be high, that there will be many trains on the road and therefore some interference to train movement, that the locomotive terminals will have large numbers of locomotives to handle, that all the facilities will have heavy loads imposed upon them. Nevertheless, to obtain maximum capacity the road and terminal movements should as a rule be free and unrestricted, and the crowding, the over-feeding of any part of the machinery reduced to a minimum. It is true that crowding of facilities will follow speedily if there are interruptions to traffic and they will doubtless be frequent. If of short duration, the resulting accumulations will be overcome by the reserve power of the organization; if of longer duration, other means of relief should be resorted to, such as the diversion of traffic to other routes and the restriction of loading by embargoes. But the remedy, whatever it may be, must be applied promptly and vigorously so as to avoid congestion and its attendant losses of efficiency and capacity. The length of time necessary and the difficulties experienced in overcoming these accumulations of freight will give some indications of the possibilities of increasing the movement of traffic over the dstrict.

It will undoubtedly be found that the officers are well informed as to the limitations of the district and can point out those facilities which are being utilized most nearly to their capacity and which first show signs of overloading, and perchance they will have available the results of experiments which have been made with the view of increasing the traffic capacity so that the expediency of possible changes of operating methods can be definitely determined without the necessity of experimentation, which is in itself very objectionable on a railroad working approximately to its capacity.

Efficiency

It will be found that the performance of the men is generally good; that trains start promptly and move into and out of sidings with precision, that there are very few accidents caused by non-observance of rules or by carelessness of trainmen; that the condition of tracks, locomotives and cars are good; that the locomotives attain a high average mileage, and the detentions for cleaning fires, washing boilers, making running repairs, etc., are reasonably low. All trains will be found to be handling the prescribed tonnage rating and the local work being done by the local freights and pick-ups, thus reserving the through trains for long haul freight. The schedules for calling extra freight trains have been so arranged that the movements of these trains will best fit in with the schedules of the passenger trains and scheduled freight trains. In short, the examination will disclose an efficiently operated

district in charge of officers who know the limitations of the facilities and who are in a position to and do take steps to restrict the business should occasion demand it so that the facilities will not be overloaded.

The subsequent study should be confined to those facilities and features of operation which, as has been developed in conference with the officers, are the first to give trouble under increases of traffic. A brief discussion of two or three assumed cases will indicate the methods to be followed.

Capacity of Facilities

Assume, first, that the ashpit at one terminal becomes overloaded and power is delayed there:

Careful observations of the operation of the pit and tracks leading to and from it should be made covering periods of sufficient length to thoroughly familiarize the observer with them. This may develop that some slight re-arrangement of tracks or other facilities will be beneficial; as, for example, the building of an additional cross-over or the re-location of a water column. It may bring out that some part of the organization needs strengthening. If the capacity of the pit itself is the limiting feature, consideration should be given to affording relief by installing steel ties in an adjoining track for a length of eighty to one hundred feet and the cleaning there of the fires of yard engines and other small power during the heavy periods of the day. Means may be found also of changing the runs of certain locomotives so that they can be taken care of at some other terminal where the facilities are less crowded, thus reducing the load on the terminal under examination.

Assume, second, that one of the yards is unable to keep up with the switching under increased business:

Observations of the work of all parts should be made by capable men. If these should develop any lost motion, interference of the work of the yard crews by other yard crews or by road crews, inefficient use of yard power, etc., by careful planning, and possibly by some minor improvements which can be quickly made, some of these difficulties can be overcome. Consideration should be given to the question of systematized classification of the freight at other yards through which it moves so as to reduce the work of this yard. If practicable a part of the trains should be so made up as to pass this yard without switching. Some feasible change in the yard power may be found advisable.

Assume, third, that the road movement gives trouble:

A study of the train sheets will indicate where to look for the cause. It may be found that a small number of additional block offices will be beneficial; that the scheduling of drag freight trains out of the terminals so as to reduce interference with schedule trains is practicable; that a very slight reduction in the tonnage rating of drag freight trains will eliminate stalling of the trains when the rail is bad, will speed up the movement and enable better use of the power to be made, and in this way the capacity of the railroad increased.

The second situation, that of congested engine district, presents an entirely different problem. It can be stated without fear of contradiction that an engine district that is continually congested for long periods can not be handling traffic to its maximum capacity. Congestion carries with it heavy delays to trains getting out of and into yards, slow movement on the road, holding trains out of yards, too many relief crews to prevent hours of service

law violations, excessive interference to switching in yards and an increased quantity of switching, crowded ashpits and engine houses, tired, indifferent men, carelessness, accidents, petty and serious, with damage to engines, cars and tracks, all resulting in inefficient use of power, of facilities, of men, in a general slowing up of the movement and in a reduced capacity of the railroad.

When such conditions exist it is necessary, in order to bring about any lasting improvements, to determine the seat and the cause of the congestion before remedial action can be taken. Congestion in one or both of the terminals at the extremities of an engine district does not necessarily affect the road conditions to any serious extent. For while it may be found necessary to set trains off at sidings on line of road and to hold other trains out of the yards for varying periods, thus causing inefficient use of power and crews, the result will be a tendency to increase the terminal difficulties, and if proper precautions are taken to safeguard the road movement it will continue to be free and unrestricted. Congested road movement on the other hand means a general slowing up of trains and a continued inefficient use of the available power and crews, so that even if the terminals are adequate to handle the traffic with free road movement they will become crowded with movable cars, switching will be made difficult, and unless handled very skilfully congestion of the terminals themselves will follow as a result of the road congestion.

If it is found that the road movement is as a rule free while one or both terminals are congested, then it is necessary to look only to the terminals for the cause of the trouble. If both road and terminals are congested the difficulty may lie entirely with the road conditions, but the chances are that the congestion in the terminals, brought on perhaps by the inadequate road movement, has been aggravated by unfavorable conditions within the terminals themselves.

The detailed studies then should embrace both road and terminal facilities, organizations and operating methods or such portions of them as the preliminary investigation may determine is necessary. They should be made by consulting the train sheets and the various daily and periodic reports of operating performance and by making comparisons with the performance during previous periods, by suitable observations of actual work and by free discussion of the problems and conditions with the officers in charge of the operations.

There is given below a synoptical outline of some of the elements which affect the capacity of a railroad, and following it a brief discussion of a number of them. The subject is covered only in a very elemental way, but its purpose is simply to indicate the method of procedure, for it is evident that each case will present a problem in itself and that each will require modifications of the general treatment.

Road Capacity Affected by

Method of train operation	Spacing system. Dispatching trains. Scheduling extra trains out of terminals. Running speed. Tonnage rating. Handling local work by locals or pick-ups. Helper stations.
Derailments and accidents	Defective track. Defective equipment. Carelessness. High speed.
Performance of power	General condition. Running repairs. Preparation. Fuel, water.

Yard Capacity Affected by

Work to be performed	Quantity of switching. Overcrowding. Yard design.
Performance of power	General condition. Running repairs. Preparation. Fuel, water.
Derailments and accidents	Defective track. Defective equipment. Carelessness.

Engine Terminal Capacity Affected by

Ashpit, turntable, coal tipple and ready track operation.
Running repairs.

Spacing System.—The spacing of trains may be by train order and rules, manual block signals, automatic block signals or otherwise. If the spacing is by train order and rules, give consideration to establishing the manual block system. The cost will probably be light and the advantages in reduced liability to accident great. Determine if the system in use is functioning properly and if additional telegraph offices or block offices or signals are required to shorten particularly long blocks. Consider the possibility of modifications of rules looking to expediting train movements without sacrifice of safety, as for example the fullest practicable use of the "19" train order.

Dispatching Trains.—A first-class train dispatcher will work wonders with a busy railroad, while one who is not capable, whether from inexperience or other cause, is entirely out of place where there is congestion. Determine if the dispatching force is competent and adequate; if the dispatchers are found up to the mark and still trains are being delayed for orders, give consideration to subdividing the district, adding an additional set of dispatchers. The dispatchers must keep a constant pressure on the train movement. They must not be on the defensive.

Scheduling Extra Freights Out of Terminals.—It will be found that the chief dispatcher calls the extra freights so as to avoid passenger trains and scheduled freight trains in getting out of the terminals. Take advantage to the fullest extent of the idea he is using. Call into conference the Superintendent, trainmaster, chief dispatcher and traveling engineer and prepare a schedule for each terminal of the leaving times of all extra trains for the twenty-four-hour period. Provide for the heaviest practicable movement with the understanding that trains scheduled for departure at certain hours can be annulled if not required. Place this schedule in the hands of the enginehouse foreman, yard foreman, and chief caller as well as in the hands of division officers; there will soon be evidence of preparation to meet the schedule, power will be selected in advance, the yard crews will speed up to get the train ready, the trainmen will watch their standing on the crew board and be prepared to promptly respond when called. Regularity and certainty will prevail and the train will leave terminal on schedule—a good start for a good run.

Running Speed.—Do the slow freights drag uphill at snail's pace, with slipping drivers, stalling if the steam pressure drops a few pounds below the maximum? When over the hill do they roll away, passing the bottom of the sag at passenger train speed—"as fast as a wheel will turn over?" Both are objectionable. The first tends to uncertainty of movement, delays, inefficiency; the second increases wear and tear on track and equipment and tends to accidents—and freight train accidents at high speed are usually serious. Moderate freight train speeds tend to reliability and safety. They sacrifice little in time saving and quicker movement as compared with excessive speeds on descending grades.

Tonnage Rating.—Increased traffic means more ton miles produced. Look well then to the tonnage rating of the locomotives. Proper tonnage rating does not mean overloading the locomotive. It does mean maximum loading for the efficient speed on the ruling grade. It means all trains of the same class uniformly loaded in the direction of heavy traffic. It means full trains from terminal to terminal. It means uniform performance. If the tonnage ratings are found to be low, do not hesitate to increase them, but do this gradually. Add one car per train and run this way for a week, then add a second car. Keep this up until the proper rating is reached and the psychological tendency to oppose increased train loads will probably be avoided. If on the other hand it is established that the rating is too high, it should be reduced. Difficulty in starting trains, slow movements into and out of side tracks, very low speed on the ruling grades, with trains stalling when the rail is bad and other unfavorable conditions exist, spell uncertainty, delays and inefficiency. Rate the locomotives to their capacity, but so as to provide a reliable, dependable movement of trains.

Handling Local Work by Locals and Pick-Ups.—To make the maximum ton mileage a train must move through one terminal to the other with full tonnage. When this is done with a minimum of delay efficient operation is obtained. If the through tonnage freights are to make good runs they must be relieved of local work, setting off and picking up at stations, so that they will have nothing before them but to make the other end of the road. This is one of the surest ways of increasing the ton miles per hour of crew time and the ability to handle traffic. If the local work is light it can all be handled by the local freight, but this local must not be overloaded. It will

necessarily meet with delays at stations unloading freight and switching, and in order to get over the road in a reasonable working day its tonnage will have to be light so that it can make quick moves from station to station and in avoiding other trains. Excessive hours on the road day after day will wear out any crew and the services will suffer as a consequence. Therefore, when the carload business is heavy, pick-ups must be run as necessary to keep the freight well moved up and the road free of cars.

Helper Stations.—If there are grades requiring helper engines, ascertain if the through trains are meeting with delays waiting for helpers. In scheduling the slow freights out of the terminals, favor the helper stations as far as practicable. Consider possible changes in the helper runs and the loading of through trains to the end of increasing the efficiency of the helper and road power.

Defective Track.—Poor track is responsible for a large percentage of derailments. There are two remedies: The first, repair and build up the track. This can be done in a short time if the defective conditions are confined to a few short stretches of line, but if they are general much more time will be required. The second, reduce the speed of trains to the safe limit. This remedy fortunately can be applied immediately with certain results. Better reduce speed of trains than frequent interruptions to traffic and expensive derailments.

Defective Equipment.—If the accident reports show an excessive number of derailments caused by defective equipment, an analysis may indicate that the inspection at a certain terminal is poor or that a particular type of car is causing the trouble. More careful inspection of all cars at terminals and quick inspections by the trainmen when standing at water stations, in sidings and in pulling into and out of side tracks will do much towards preventing these derailments.

Carelessness.—Accidents resulting from non-observance of rules and carelessness are an indication of demoralization. Switches run through, switches thrown under moving locomotives or cars, short flagging, improper train handling, result in derailments, collisions, destruction of cars, damage to locomotives, delays and serious interruptions to traffic. Such a situation requires strict but careful discipline, thorough and relentless investigation of all accidents and detected breaches of rules and the free use of efficiency tests. Proper methods will slowly but surely overcome the spirit of carelessness and as conditions improve there will appear among the men a spirit of pride in being a part of an alert, effective organization.

High Speed.—Excessive speed will cause derailments even if the track and equipment are in good condition; in combination with defective track and equipment it is a fruitful source of accidents. Derailments of trains running at high speed usually result in serious wrecks, with heavy damage to property and serious delays to traffic. The remedy is to reduce the speed of the trains; to place restrictions where required, holding the speed well within the limits of safety.

General Condition.—On a congested railroad there is almost sure to be found a shortage of good serviceable power. There may be an abundance of locomotives; in fact, there are frequently too many, but so often the average condition is low and the number of locomotives actually available for service

falls short of the requirements. A freight locomotive after receiving general repairs should be good for approximately twelve months' service. For the power condition to be good then 50 per cent or more of the locomotives should be good for more than six months' service and a very small number should be awaiting shop. If too many of the locomotives are good for only one, two or three months' service the number of failures will be large, the running repair force will fall behind in their work and the power conditions will drop further and further behind instead of improving. The remedy for such a condition is to assign to the district more shop space or to increase the output of that assigned by double shifting in the machine shop, the boiler shop or that part or parts of the shop which is limiting the output. To afford prompt relief consider having a number of locomotives repaired by other railroads or by contract shops.

RUNNING REPAIRS.—If there is any one thing that is disheartening to a train dispatcher it is to have on a busy railroad two or three locomotives that are performing poorly—failing. If the failures are not complete and the locomotives are able to limp into terminals with their trains, their movements will be slow and unreliable and the delays to these and other trains will be serious; if the engines give up their trains after exasperating delays other locomotives will have to be dispatched light to move in the trains. All of this makes for inefficiency and reduced capacity of the railroad. Running repairs are those required to place the locomotive in condition for a successful trip over the district. If properly made there will be few failures. Insist on the running repairs being well done. Do not dispatch a locomotive until all required repairs are completed. If neglected, the failures will be many. Watch closely the number of engines held for running repairs; if too high, ascertain the trouble and apply the remedy. If necessary increase the force assigned to running repairs, as a last resort reducing the force on general repairs in order to do this. By all means see that this work is kept close up, for it means the maximum number of serviceable locomotives and good performance on the road.

PREPARATION.—Locomotive failures may occur from broken or wornout parts—defects in the locomotive itself—or from conditions resulting from improper preparation, such as obstructed flues, foul boiler, dirty fire, etc., those conditions other than repairs which are remedied in preparing the locomotive for the next trip. If it is developed that the failures are being caused by improper preparation, look to the ashpit and enginehouse forces to remedy this. It may be well to temporarily place a special inspector to thoroughly inspect and approve the condition of all engines before they are turned over to the road crew.

FUEL AND WATER.—Determine if the fuel is of good quality and adapted to the locomotives. Also that the locomotives are suitably drafted to burn the fuel. If the fuel is poor a great opportunity for increasing the capacity will be presented provided a suitable quality of fuel is available. If the water is generally bad the problem is serious, but some relief may be had by the use of boiler compounds and other such expedients. If only one or two water stations cause the trouble, avoid the use of water from them as far as practicable. Consider relief through hauling water of good quality, water treating facilities, or larger tanks.

Quantity of Switching.—Freight trains can be put through a terminal with regularity in from ten to thirty minutes if there is no switching to be done. If they have to be broken up and classified, consolidating with other trains, several hours will be required. If the ability to move freight through a given yard is the limit of the capacity of the district and the switching is heavy, every effort should be made to reduce the switching in this yard. Consideration should be given to doing certain of the switching at other yards in order to reduce the work at this one. This may consist of building at other yards of solid trains to pass through this yard without classification, of routing some of the freight around the yard if practicable and of reducing the work in this yard by well-planned use of the tracks and by systematizing the switching.

Overcrowding.—The work of any yard will be badly hampered if it is continually overcrowded. Effective switching requires open tracks into which to throw the cars. With crowding comes the frequent blocking of running tracks, the interference with switch engines by other switch engines and by road engines, increased liability to collisions and accidents, forced departures from the usual plan of switching and operation, all tending to inefficiency and reduced capacity. The remedy is to divert some of the freight so that it will not be handled in this yard or to reduce the traffic temporarily by embargoes until normal operating conditions are restored.

Yard Design.—While any extensive changes in a yard under heavy traffic would not come within the scope of this particular study, careful consideration should be given to the possibilities of increasing the capacity of minor changes in design. For example: It may be found advisable to raise the summit of a hump a foot or two so as to give the cars a quicker run-off; to lengthen a few tracks so as to avoid road trains doubling over; to make changes in the arrangement of switches at some point so as to avoid interference and reduce switch engine movements; or to put in a stand pipe and prevent loss of time on account of switch engines running for water. In general, the effect of the performance of power, derailments and accidents on yard operation is similar to that on road operation, and the discussions of the causes and conditions affecting them given above can be applied with suitable modifications to adapt them to yard work.

Ashpit, Turntable, Coal Tipple, and Ready Track Operation.—Determine if the facilities and appliances are maintained in such condition as to give efficient operation; if coal and cinder cars are promptly switched to and from the coal tipple and cinder tracks as required; if the necessary tools, torches, etc., are provided. Careful observation should be made to determine if any changes in routing of locomotives to and from the ashpit and engine house will reduce the interference and promote freedom of movement. The ashpit and other forces handling the locomotive should be studied to ascertain if there is any lost motion on account of lack of force, improper arrangement of force or weaknesses in the organization. Men of strong character are required to supervise the work around an overloaded engine terminal and any expenditure made in improving the organization will pay large returns in increasing the capacity of the railroad.

Running Repairs.—It may develop that the locomotives are passing promptly over the ashpit but are being delayed getting into the engine house

on account of the inability of the engine house organization to promptly handle the running repairs. Such a condition may be found to be caused by inadequate engine house force and equipment, by failure of other terminals to properly make running repairs to the locomotives, by neglect of the locomotives on the road by engine crews to such an extent that defects arising on line of road result in much heavier damage to the locomotives than should occur, or to a shortage of power, causing the locomotives to be run out without proper running repairs and this leading to failures on line of road, causing much damage to the equipment and consequently requiring a great deal more time and expense for repairs than would have been the case if the locomotives had been in proper condition when dispatched. When such conditions are found they should be remedied promptly by methods which will doubtless suggest themselves as the most practical. If the force can be added to so as to increase the capacity of the enginehouse for making running repairs this should be done. Steps should be taken to insure proper handling of the locomotives when on line of road and by all means proper running repairs should be made before the locomotives are dispatched. By selecting those locomotives requiring the lightest repairs and concentrating on them, they can be dispatched promptly, while those requiring heavy repairs can be held so that the work can be properly done. If all locomotives are placed in first-class condition as to running repair work before dispatched the trains will move with precision and reliability, the locomotives will make quicker trips between terminals and produce more train miles. The same number of trains can be handled with a less number of locomotives. By following this method those locomotives requiring heavier running repairs can gradually be put in good condition one by one until all of the power of the district is brought up to a high standard, the running repair work per locomotive will be reduced and the efficiency of the power and with it the traffic capacity of the district increased.

(II) STUDY OF RAILROAD OPERATION WITH VIEW OF INCREASING ITS CAPACITY BY PROVIDING ADDITIONAL FACILITIES

In many cases it will be found that the only solution for obtaining increased traffic capacity is by means of new facilities of one kind or another. The purpose of the following discussion is to obtain a conception of the physical elements which determine the traffic capacity of a line and to show how operating results may be analyzed so as to form the basis for comparing the costs of providing new facilities and the financial and operating benefits to be gained therefrom. Such analyses will be of value in forecasting the operating results to be obtained and in establishing the feasibility of proposed undertakings for increasing the traffic capacity or improving the service.

Traffic Capacity.—The term "traffic capacity" conveys the idea of tonnage capacity, that is the maximum tonnage which can be moved regularly over a given arrangement of tracks in a given time. For the purpose of this discussion no account will be taken of insufficient yard capacity in dealing with the elements which determine the traffic capacity of that portion of the road between terminals. On this basis the traffic capacity will depend upon the weight of trains and the number of trains which can be operated over the given arrangement of track in a given time. The weight of trains will

depend upon the size of locomotives employed. The number of trains will depend upon how fast the locomotives will haul them and upon the arrangement of tracks. Traffic capacity therefore depends upon a number of variables and hence cannot be expressed in terms of any one unit.

On the other hand it will be shown that the "track capacity" of any section of road between terminals depends wholly upon the number and arrangement of sidings or passing tracks in the case of single track lines and upon the minimum allowable headway between trains in the case of multiple track roads. Also the theoretical track capacity is a definite quantity which can be measured in terms of train hours.

Track Capacity of a Single Track Line.—For the purpose of illustration, assume a single track section 100 miles long with passing sidings 10 miles apart. This line will be made up of ten single track sections between sidings (see Fig. 1). When these sections are all occupied at the same time it can be assumed for the moment that the road is being operated at full capacity. On this basis there will be ten trains on the line at the same time and if this condition lasts for twenty-four hours then the daily capacity of the line can be expressed by the product of the number of trains constantly on the line and the number of hours, in this case $10 \times 24 = 240$ trains per day.

One way to have every track section occupied at the same time is to dispatch trains so that each train meets another train going in the opposite direction at every siding. This means that trains have to be started simultaneously from opposite terminals at intervals equal to twice the distance between sidings, in this case 20 miles apart. If each train makes 10 m.p.h. they will have to be started from the terminals at intervals of every two hours. At 10 m.p.h. each train would be on the road 10 hours and since the trains are two hours apart, it would be possible to dispatch 12 trains from each terminal in 24 hours, or 24 trains per day, each train taking 10 hours makes 240 train hours per day.

If the trains make 12½ m.p.h. and are spaced 20 miles apart they would be started from the terminals at intervals of 1.6 hours (see Fig. 2). Each train would be on the road 8 hours and it would be possible to dispatch 15 trains from each terminal in 24 hours or a total of 30 trains per day, each train taking 8 hours makes 240 train hours per day, as previously found.

Track Capacity of a Double Track Line.—If the illustration is carried a step or two farther the track capacity of a double track line can be shown. Suppose there are two lines each 100 miles long, one having ten single track sections between terminals and the other fifty single track sections between terminals. The capacity of the latter line will be according to the above rule $50 \times 24 = 1200$ train hours, or five times the capacity of the former. In the case of the 10 section line there will be the equivalent of 10 sidings against 50 sidings for the 50 section line. If the sidings are all the same length in both cases (1 mile) then the amount of side track in the two cases is proportional to the relative capacities. When a point has been reached where the section between sidings is the same length as the sidings then the next step is double track. Assume this is the condition for the 50 section line assumed above and to make it double track will require 50 miles of additional side track. By the same reasoning the capacity of the double track would be

twice the capacity of the 50 section line and 10 times the capacity of the 10 section line. In other words, the relative capacities of two lines are proportional to the relative amounts of passing tracks in the two cases. Thus the track capacity of a line which has a track mileage in sidings equivalent to one fourth of the main line would be increased four times if the line were double tracked. Likewise the capacity of a line which has one fifth of the main line mileage in sidings could be increased five times if it were double tracked, etc.

Typical Train Charts
Showing Simple Cases of Perfect Operation
Trains of One Class

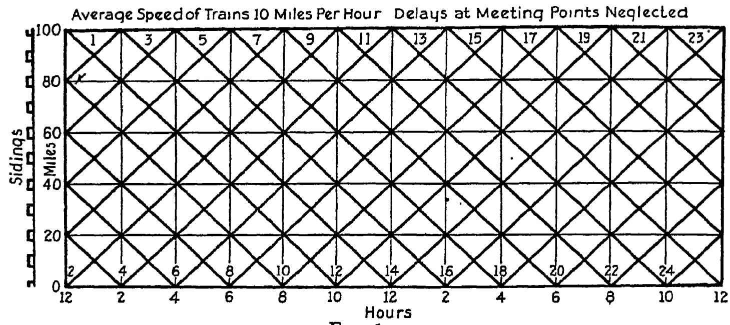


FIG. 1

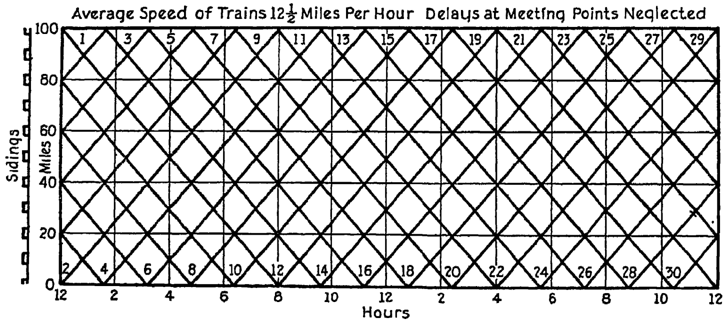


FIG. 2

This is not strictly true unless a limit is placed on the headway between trains on double track lines. In the case of a single track line the minimum headway between trains in the same direction is twice the distance between center lines of sidings which in the limiting case is four train lengths. On a double track line, trains in the same direction may be operated theoretically on any headway, but in order for the above rule to be true trains in the same direction must be operated one train length apart, that is, two train lengths

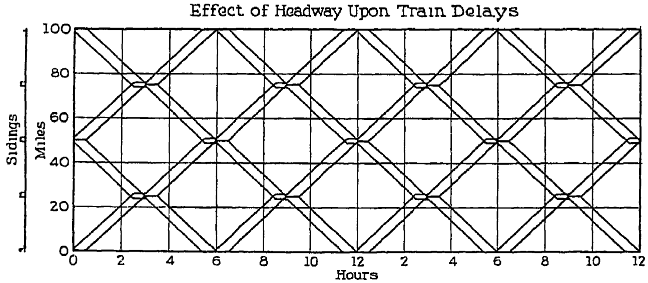


FIG. 3

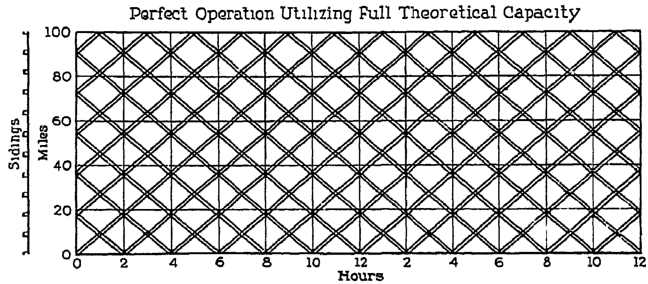


FIG. 4

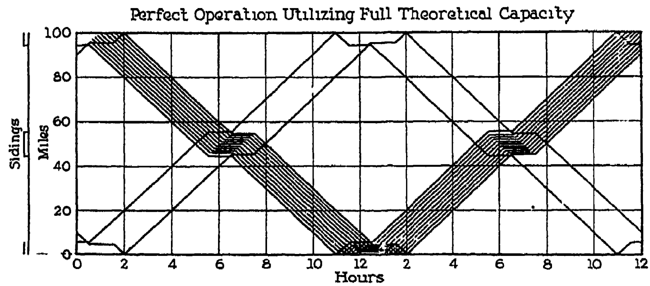


FIG. 5

between the head end of one train and the head end of the next. If a value of one mile is assumed for the length of train then the daily track capacity of a multiple track line expressed in train hours is equal to 12 times the number of tracks times the miles between terminals.

Fleet Operation.—If the sidings are designed for passing two or more trains at a time it will be possible to operate trains in fleets, that is, two or more trains following each other in a section at the same time as shown in Fig. 3. In this case the theoretical capacity is increased in proportion to the number of trains in the fleet. It is impossible, however, to use the full capacity obtained by this rule unless trains are operated on the minimum headway of one train length apart, that is two train lengths between head ends. It can be shown for trains operated in fleets that the minimum delay per train at each meeting point is equal to the headway between trains less the time required to run the length of one train multiplied by one less than the number of trains in the fleets. Thus for two trains in a fleet running at 10 m.p.h., 12 minutes apart, assuming the trains are each a mile long, the delays at meeting points will be 12 minutes less 6 minutes (the time required to run 1 mile at a speed of 10 m.p.h.) or 6 minutes per train.

If the fleets consist of 11 trains, each 12 minutes apart, the delays per train at meeting points will be 10×6 or one hour per train.

In the case of two trains per fleet, if there are 11 single track sections in a hundred miles, the theoretical track capacity based on two trains per section will be $2 \times 11 \times 24 = 528$ train hours per day. On the basis of 100 miles in 11 hours, including delays, fleets can be operated at intervals of every two hours from each terminal or a total of 24 fleets of two trains each, and taking 11 hours per train makes 528 train hours per day.

The miles of track in sidings under this condition is twice what it would be under single train operation, and the track capacity is correspondingly double by reason of the increased length of sidings.

Fig. 5 shows fleet operation of eleven trains per fleet with sidings at the ends and in the middle long enough to hold eleven trains. The theoretical track capacity of this arrangement is according to rule, 2 (sections) $\times$ 24 (hours) $\times$ 11 (trains)$=$528 train hours per day which is the same as for the 11 section line which contains the same amount of passing track (22 miles) distributed at short intervals. Four fleets of eleven trains each can be operated per day each train taking 12 hours making 528 train hours.

It is interesting to note that on the basis of 10 m.p.h. and a minimum headway between trains of one train length, assuming trains a mile long, eleven trains are the greatest number of trains per fleet which can be operated over the indicated arrangement of tracks and obtain two complete cycles in 24 hours. If the speed is increased to 15 m.p.h., other conditions remaining the same, eleven trains are the greatest number of trains per fleet which can be operated over the indicated arrangement of tracks and obtain three complete cycles in 24 hours. At 20 m.p.h. the greatest number of trains which can be operated per fleet and obtain 4 complete cycles in 24 hours is eleven. In other words, the theoretical track capacity of a section of line will be the same for fleet operation as for single train operation provided there is the same amount of passing track in the two cases and arranged accordingly.

ACTUAL VERSUS THEORETICAL TRACK CAPACITY.—The above illustrations give a conception of track capacity which is perhaps new and show how the theoretical track capacity of a perfectly laid out line can be determined. It is important to emphasize the point that the theoretical track capacity is fixed by the arrangement of tracks and can be given a value in train hours. The actual track capacity may not be as definitely fixed, but it is manifestly less than the theoretical track capacity and possibly can be assigned some value expressed in train hours which will represent the actual use which can be economically obtained from the tracks. It is surprising to learn how the introduction of simple operating conditions limits the capacity which can actually be used.

In the first place, on a single track road where the sidings are designed for passing only a single train at a time, meets cannot be arranged so that neither train is delayed. One or the other, or both trains, will be delayed at each meeting point. Fig. 6 shows the condition where one train and then the other are delayed at alternate meeting points.

It has been assumed for the purpose of the previous discussion that the sidings are all equally spaced and the speed of trains is uniform. If the sidings are not equally spaced but the speed of trains is uniform then the number of trains which can be operated over the line will be governed by the time it will take for a train to make the run over the longest section in both directions. That is if the middle siding in Fig. 1 were omitted the middle section would be 20 miles instead of 10 miles long, and it would take two hours for a train to run over this section in one direction and two hours for an opposing train to run back, so that the minimum interval between trains in the same direction would be four hours instead of two. In other words, the capacity of the line would be reduced to half which is equivalent to omitting every other siding.

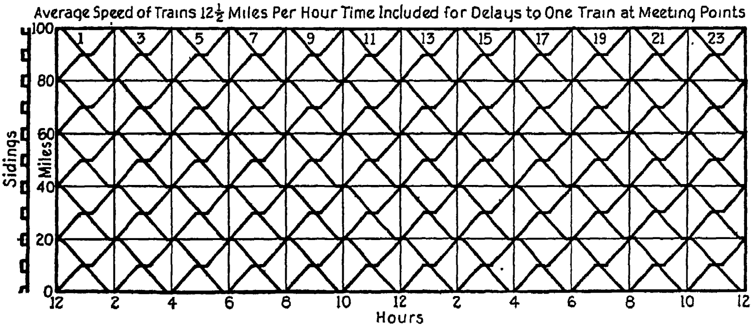


FIG. 6

If the speed of trains is not uniform then the sidings should be spaced so that they are equidistant as regards time rather than distance. These are some of the elements which should be investigated in setting about to improve the traffic capacity of any particular section.

Determination of Actual Track Capacity

In most cases the actual capacity of any section of a railroad can only be determined from actual operating experience. Until the traffic reaches a point where it taxes the capacity of the facilities to handle it there is no way of telling what the track capacity actually amounts to.

On account of the irregular spacing and length of sidings, size of trains, etc., there is even some question about the theoretical track capacity in actual cases. Not all sidings are long enough to pass full length freight trains and some are longer than necessary for that purpose. Because of these conditions every siding is not 100 per cent effective even theoretically and in order to have some basis for comparison it becomes necessary to define theoretical track capacity on the assumption that 100 per cent use can be obtained from all passing tracks. In other words, it is proposed to consider the theoretical track capacity of any section is obtained by assuming that the total amount of passing track is arranged in such a manner that all sidings are only long enough to hold full length freight trains and spaced so as to be equal time intervals apart. Under this arrangement 100 per cent use can be obtained from passing tracks under maximum conditions.

The theoretical track capacity may therefore be expressed in train hours per day as follows:

$$\text{Theoretical Track Capacity} = \frac{(L_1 + L_2)\,5280 \times 24}{2 \times Z}$$

Where L_1=Miles of second track.
L_2=Miles of sidings.
Z=Length of freight train in feet.

In actual cases it will be seen that first of all the track arrangement precludes obtaining anywhere near the theoretical track capacity; secondly, the requirements of the service means sacrificing some capacity which might otherwise be used. For example, the nature of the traffic may be such that the majority of freight trains must leave or arrive at terminals within certain prescribed hours. Some of the facilities required at these times would be idle at other times so that actually the facilities are only partially effective.

On long divisions the actual track capacity is governed largely by the effect of the sixteen hour regulation because of the number of crews which have to be relieved when the train density reaches high figures. If the division were divided in two, the sixteen hour regulation would not be effective until much higher train densities were obtained, hence the length of the division may be a factor in determining the actual track capacity.

On account of the fact that a surplus track capacity also serves to minimize delays it will be found that the actual use obtained from track facilities during seasons of heaviest traffic periods is seldom more than 15 per cent of the theoretical track capacity obtained by the above formula. This may also be due to the fact that track facilities are unbalanced and some limiting section is being operated near its theoretical capacity.

Effect of Operating Two Classes of Trains.—There is another important element which enters into nearly every railroad operation, namely, the condition of operating more than one class of trains over the same tracks

or the condition where superior trains overtake as well as meet inferior trains. This is one of the reasons why perfect performance cannot be expected in actual operation and why railroads need many more facilities than they can ordinarily make use of.

Fig. 7, 8, and 9 show how one passenger train making a round trip would delay freight trains if the sidings were only long enough for one freight train. One freight train in each direction must be abandoned to accommodate the passenger train and if the speed of the passenger train is more than double the speed of freight trains, two freight trains in each direction must be abandoned to accommodate a round trip for a passenger train.

Fig. 10, 11 and 12 show that when two passenger trains are on the line at the same time, two freight trains in each direction have to be abandoned. A study of the effect of passenger train operation upon freight train performance, Vol. 25, page 708, indicates that the effect of three passenger trains is equivalent to five freight trains.

In addition there are many other conditions which complicate actual operation such as an irregular profile, variable weights of trains, stops for coal and water and delays from other causes, bad meets, failure of equipment, etc. On a double or multiple track system some of these conditions are more or less minimized but the problem is the same whether the road is single or multiple track. Because of the difficulties found in properly allowing for all of these conditions, another method which makes use of Train Hour Diagrams has been devised for the purpose of analyzing actual train operations.

Train Hour Diagrams.—In the previous discussion it was assumed that every train could be operated perfectly, that is, all trains would be on the road the same length of time. On this basis if every train were represented by a cardboard strip and the times on the road were represented by the length of the strips, all the strips would be the same length, so that when they were stacked one on top of the other, the edge on view would be a rectangle, the height of which would indicate the number of trains, and the length the number of hours on the road. The area would represent the total train hours.

In an actual case if every train during a given period were represented by a cardboard strip and the time on the road indicated by the length of the strip, all of the strips would not be the same length. If they were sorted and arranged according to lengths and stacked as before with the longest strips at the bottom, an edge on view would resemble the train hour diagram shown in Fig. 13. The area of this diagram would represent the total train hours of all the trains. If every train operated as well as the best, it could be assumed that all trains were operated perfectly and the rectangle enclosed by the dotted vertical line would show theoretically perfect operation as compared with actual operation as shown by the whole train hour diagram. The reason why there is so much difference between theoretical and actual operation is because in actual operation conditions are such that delays due to different causes occur to some trains and not to others. In other words, actual operation cannot be perfect because there are always elements of chance which have to be taken account of. The train hour diagram is a convenient way of showing the combined effect of all of these various elements. As will be shown later it is quite easy to find a mathematical solution for a number of typical problems relating to actual train operation.

Typical Train Charts
Showing Simple Cases of Perfect Operation
Trains of Two Classes

Only One Passenger Train on Road at a Time. Delays to Freight Trains for Meets with Passenger Trains Shown. Other Delays Neglected. Based on Single Sidings.

Average Speed. Passenger Trains $1\frac{1}{2}$ Times Speed of Freight Trains
Average Speed Freight Trains Neglecting Delays 10 Miles Per Hour

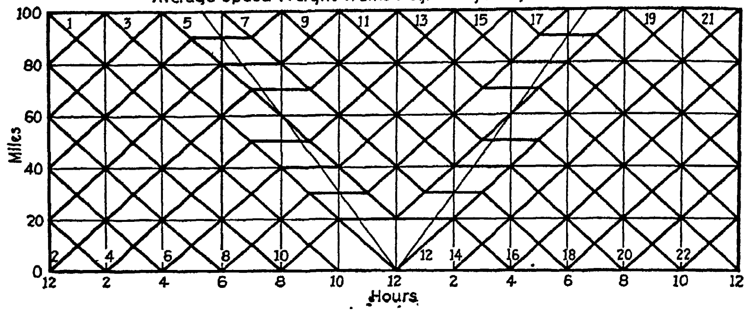


Fig. 7

Average Speed Passenger Trains 2 Times Speed of Freight Trains
Average Speed Freight Trains Neglecting Delays 10 Miles Per Hour

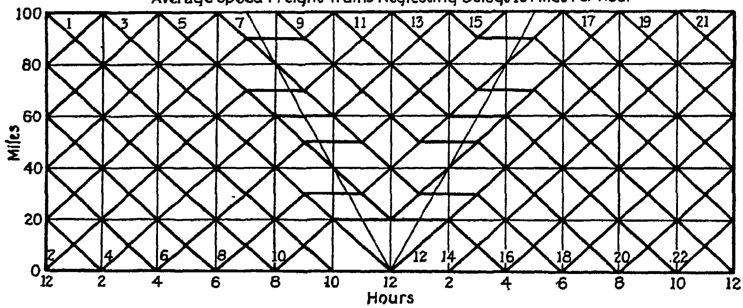


Fig. 8

Average Speed Passenger Trains $2\frac{1}{2}$ Times Speed of Freight Trains
Average Speed Freight Trains Neglecting Delays 10 Miles Per Hour

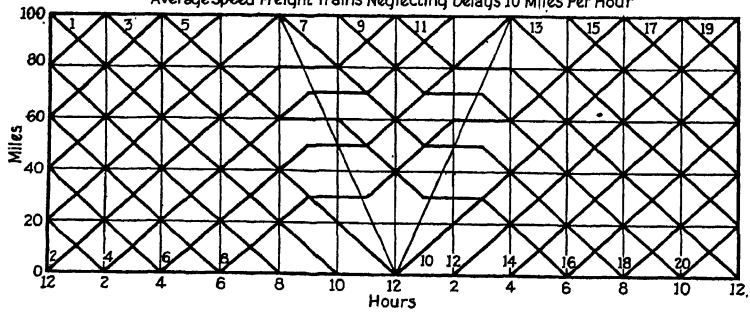


Fig. 9

Typical Train Charts
Showing Simple Cases of Perfect Operation
Trains of Two Classes

Two Passenger Trains on Road at a Time. Delays to Freight Trains for Meets with Passenger Trains Shown. Other Delays Neglected. Based on Single Sidings.

Average Speed Passenger Trains 1½ Times Speed of Freight Trains
Average Speed Freight Trains Neglecting Delays 10 Miles Per Hour

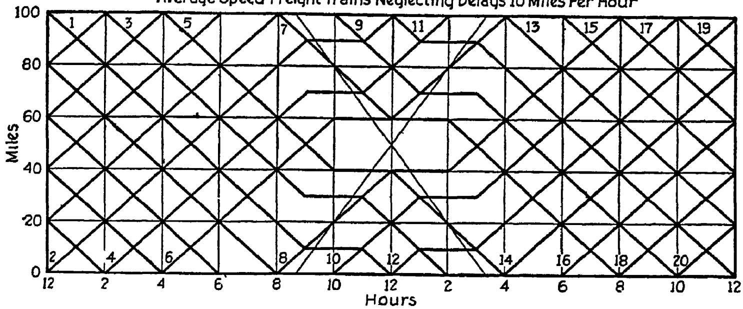


FIG. 10

Average Speed Passenger Trains 2 Times Speed of Freight Trains
Average Speed Freight Trains Neglecting Delays 10 Miles Per Hour

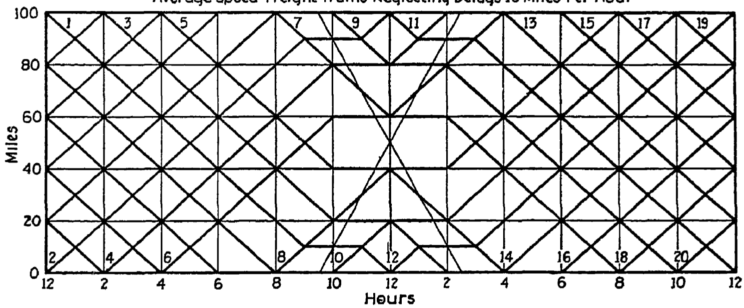


FIG. 11

Average Speed Passenger Trains 2½ Times Speed of Freight Trains
Average Speed Freight Trains Neglecting Delays 10 Miles Per Hour

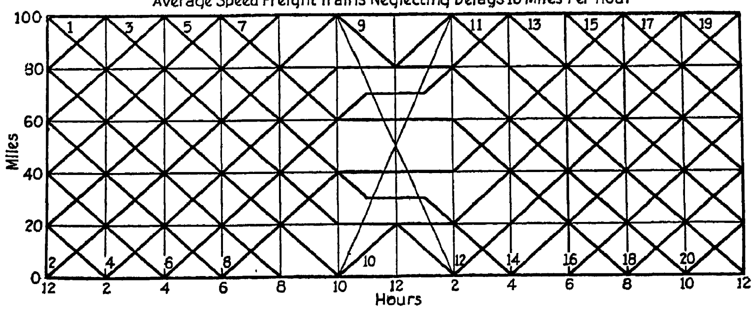


FIG. 12

One of the objects of train hour diagrams is to give a graphic representation of the performance of freight trains during any selected period. For example, the train hour diagram shown in Fig. 13 represents the performance of 141 trains operated over a period of several consecutive days during a time of heavy traffic. Out of this 141 trains only four trains were on the road less than 10 hours and only 6 trains were on the road more than 16 hours. If it is desired to know how many trains were on the road 11 hours or more follow the vertical line corresponding to 11 hours to its intersection with the broken line and read the number (119) corresponding to the horizontal line through the same point on the broken line. The diagram does not indicate directly the number of trains which were on the road just 11 hours. In this case there were only two trains on the road just 11 hours as indicated by the height of the step at 11 hours.

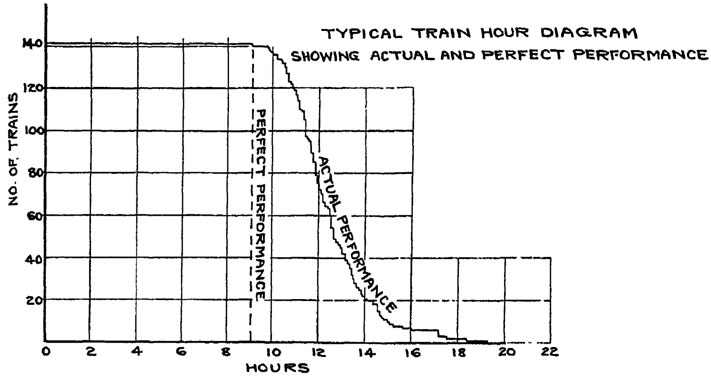


Fig. 13

Crew Expense Diagram.—A simple application which can be made of this method of assembling operating data is in connection with the study of crew expense. The train hour diagram ABCD, Fig. 14, represents the hours crews were on duty. Assuming that the district was 150 miles long, overtime would begin after 150/12.5=12 hours. All crews who were on duty 12 hours or less would be paid the mileage rate for 150 miles which is equivalent to 12 hours pay at the hourly rates. Thus in the case assumed 15 crews were on duty 12 hours or less but having made 150 miles, the pay is the same as though they had been on duty 12 hours. Hence, the hours paid for can be represented by the vertical line EG, Fig. 14. All crews who were on duty more than 12 hours would be paid straight time at the hourly rates for 12 hours and overtime rates for all time over 12 hours. The area GCF represents the total overtime crews worked during the given period. The overtime rates are 50 per cent higher than the hourly rates, thus the hours paid for will be equivalent to 1.5 times the actual hours overtime; therefore, the area GHF, which is 50 per cent greater than area GCF, represents the hours paid for on the straight time hourly wage scale. In other words, the area ABCD represents the hours crews were on duty and the area AEGHD represents the total hours paid for assuming one rate of pay.

The area BEG may be considered "bonus" time and the area GHC "punitive" overtime.

If the basic day were defined as "100 miles or less 6 hours or less" instead of "100 miles or less 8 hours or less" overtime for a district 100 miles or less in length would begin at 6 hours instead of at 8 hours and for a 150 mile district overtime would begin at 9 hours instead of at 12 hours. If the mileage rate remains the same as for the basic 8 hour day, the pay for 6 hours would be the same as the pay for 8 hours for a 100 mile run, or for a 150 mile run the pay for 9 hours would be the same as the pay for 12 hours. Thus the straight time pay for a 150 mile run can be represented by the rectangle AEFD, Fig. 15, the same as in Fig. 14.

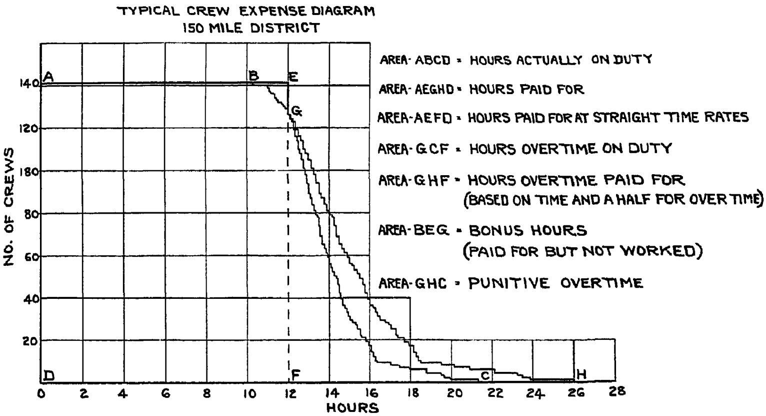


FIG. 14

In the case of a 150 mile run, overtime begins at 9 hours, hence the area E′BCF′, Fig. 15, represents the overtime hours worked on the 6 hour basis, but since the rate per hour is 1/6 instead of 1/8 of the daily rate, the area E′BCF′ must be increased 1/3 (Area EB′C′F) to be comparative with the overtime on the 8 hour basis and again increased 50 per cent (Area EKH′F) to indicate time and a half for overtime. Thus it will be seen that on the 8 hour basis the pay for 1963 hours worked in equivalent to 2112 hours at straight time hourly rates whereas on the 6 hour basis the pay corresponds to 3074 hours which in this case is equivalent to an increase in pay of 45.5 per cent. The following shows how the above estimate is obtained.

8-HOUR BASIC DAY

Hours on Duty..........Area	ABCD =		1963 Hours
Hours Overtime ....Area	GCF =		280 Hours
Straight Time Hours......Area	AEFD =	12 × 141 =	1692 Hours
Hours Overtime ....Area	GCF =		280 Hours
Punitive Overtime Hrs.....Area	GHC =		140 Hours
Total Hours Paid for.....Area	AEGHD =		2112 Hours

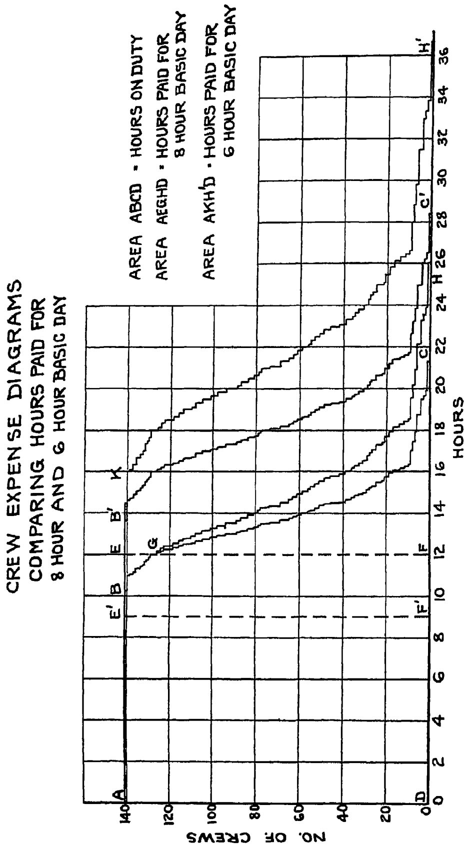

CREW EXPENSE DIAGRAMS
COMPARING HOURS PAID FOR
8 HOUR AND 6 HOUR BASIC DAY
AREA ABCD = HOURS ON DUTY
AREA AEGHD = HOURS PAID FOR 8 HOUR BASIC DAY
AREA AKH'D = HOURS PAID FOR 6 HOUR BASIC DAY
NO. OF CREWS
HOURS
A
B
E
E'
B'
G
K
C
C'
D
F
F'
H
H'
0
20
40
60
80
100
120
140
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36

FIG. 15

6-Hour Basic Day

Hours on Duty...........Area	ABCD =	1963 Hours
Hours Overtime ....Area	E'BC'F =	691 Hours
Straight Time Hours......Area	AE'F'D+1/3 = AEFD =	1692 Hours
Hours Overtime ....Area	E'BCF'+1/3 = EB'C'F =	921 Hours
Punitive Overtime Hrs.....Area	B'KH'C'=1/2 × EB'C'F =	461 Hours
Total Hours Paid for.....Area	AKH'D	3074 Hours

On account of the fact that the engine crews usually go on duty before the train crews, it is customary to construct the crew expense diagrams based upon the enginemen's hours, and assume that the one diagram applies to both engine and train crews. Ordinarily no attempt is made to show the hours paid for when necessary to relieve crews which have been on duty 16 hours.

It is possible in some cases, such as the example illustrated, to note the effect of the 16 hour regulation particularly when the theoretical train hour diagrams are superimposed on the actual train hour diagrams as shown by the smooth curves in Fig. 16. As explained later, the equations for the theoretical curves which closely approximate the actual curves can be derived from two points, a and b.

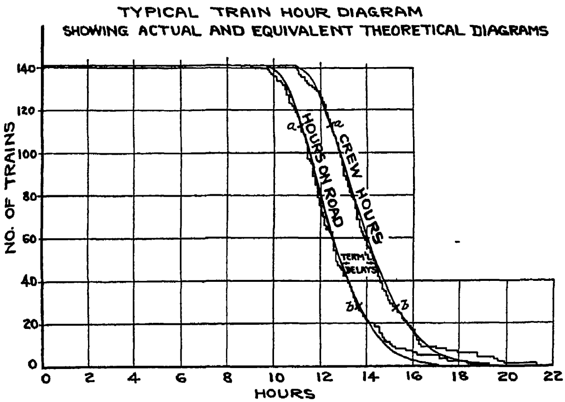


Fig. 16

In the case of the train hour diagram for crew hours the theoretical and actual diagrams agree closely throughout most of their length, but on account of the fact that crews have to be relieved after 16 hours, the actual train hour diagram is distorted at the lower end. There were actually 16 crews out of 141 who were on duty more than 16 hours. The theoretical diagram indicates that there should have been 15.5 crews determined mathematically. Between 16 and 16.5 hours the actual diagram is below the theoretical, indicating that a special effort was made to get trains into the terminal yard where the crews could be relieved by the yard crews at the expiration of 16 hours. Beyond 17 hours the actual diagram is above the theoretical, indicating in this

case that 9 crews were possibly relieved outside of the yard. Judging from the horizontal distance between the theoretical and actual diagrams the time required to relieve a crew on the road amounted to about two hours.

It frequently follows when there is a distortion of the train hour diagram for crew time, there is also a distortion of the train hour diagram for road time as indicated in this case. There are other conditions which tend to distort the actual train hour diagram, such as a combination of fast and slow freight trains in one diagram, but generally it will be found that actual and theoretical diagrams agree remarkably close. Because of this fact the theoretical train hour diagram can be substituted for the actual train hour diagram and certain mathematical relationships derived which can be assumed will hold approximately true for actual train hour diagrams.

Model for Studying Train Hour Diagrams.—In order to explain some of the applications of Train Hour Diagrams it is proposed to refer to models as illustrated in Fig. 18, 19, and 20. A description of the construction of these models will help to bring out some of the relationships which are demonstrated mathematically in Exhibit A.

Effect of Number of Trains Upon Freight Train Performance.—If the number of trains over a given section of a railroad varied from a few trains to many trains per week it would be possible to construct a number of actual Train Hour Diagrams covering a wide range of conditions as regards train density from which it might be possible to study the effect of the number of trains upon train performance.

In order to analyze the results, suppose the theoretical Train Hour Diagrams were calculated and plotted on forms similar to Fig. 17. If Part I of each diagram were cut out in the form of a silhouette, a stack of silhouettes of various dimensions would be obtained depending upon the number of trains operated and the performance during various periods. Suppose a filing arrangement were designed with guide cards evenly spaced to hold the silhouettes in the proper relation according to the number of trains. From the mathematical theory such a file of train hour diagrams would resemble the model shown in Fig. 18.

Train Hour Diagrams from such a file would show various details in connection with train performance and would enable one to tell the number of crews which would make overtime or would be on duty 16 hours or more under such conditions as may be assumed.

Suppose the average time of all the trains were indicated by a dotted line as shown in Fig. 17 and a hole punched in the horizontal axis extending part way into Part II. This dot or punchmark will indicate the average time corresponding to a given number of trains. When Part II of all the diagrams are filed in accordance with the number of trains, the punch marks on equally spaced guide cards will appear in a straight line as indicated by the fact that a round rod can be laid in the groove. See Fig. 19. If the first card in the file represents zero trains and is punched to correspond to the minimum time shown on the train hour diagrams, the round rod will be in the hollow. Thus it will be seen that the increase in average time varies directly with the number of trains operated in a given time or with the train density other conditions remaining the same. In actual operation it is difficult to select different periods when other conditions are identical, consequently results obtained from

periodic reports of the operation of a given section may only approximate a straight line when plotted. When there is a wide variation from a straight line it is often possible to find the reason for the variation by investigating the operating conditions at the time. For instance, September and October are usually two of the heaviest traffic periods on most railroads. The performance during these two months is generally better than the average, largely because of more intensive supervision, additional trainmasters, road foremen of engines and a greater number of open telegraph offices, better dispatching, etc.

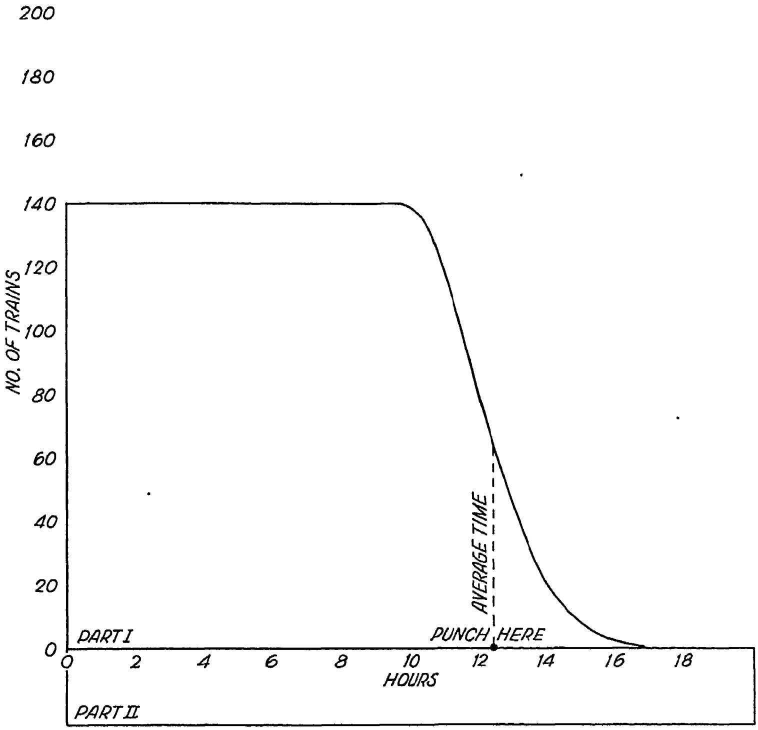


Fig. 17

On the other hand, January and February may be light traffic periods with adverse weather conditions tending to make the performance during these two months worse than the average. When the points are plotted they may fall wide of a straight line due to the wide difference in conditions or conversely if the points for different periods fall wide of a straight line it is sometimes possible to discover operating conditions to account for the variations from a straight line.

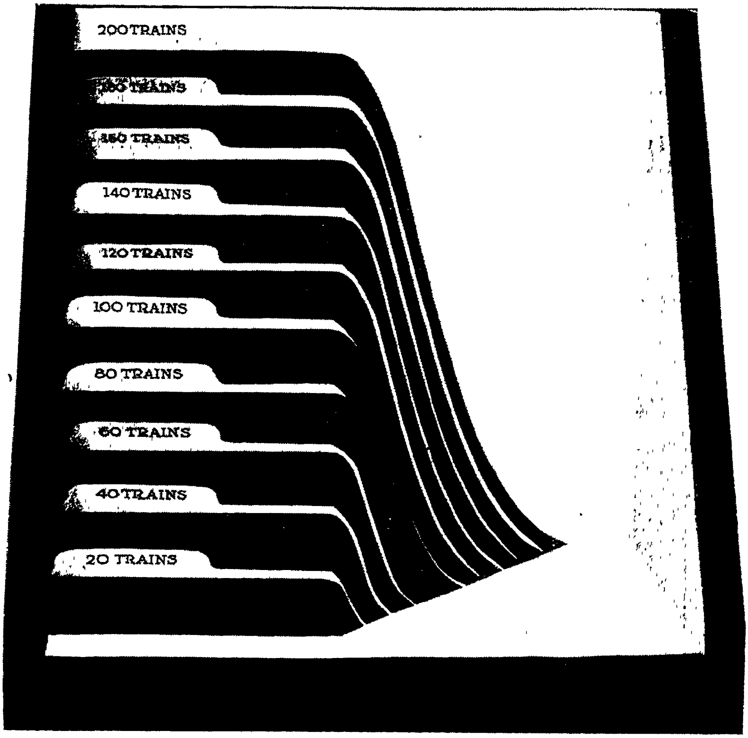

200 TRAINS
140 TRAINS
120 TRAINS
100 TRAINS
80 TRAINS
60 TRAINS
40 TRAINS
20 TRAINS

FIG. 18

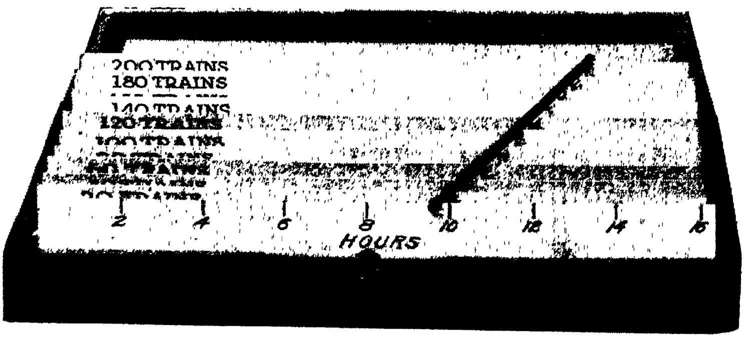

180 TRAINS
2
4
6
8
10
12
14
16
HOURS

FIG. 19

Effect of Length of Division upon Freight Train Performance.—If there are two sections of line with similar profiles but of different length, the minimum times and the average times for the same number of trains should be proportional to the distances assuming the same weight trains and the same motive power. Thus if the division is doubled one would expect that the minimum time would be doubled and likewise the time of all other trains, which means that the average time would be doubled. Thus if it is desired to use the models Fig. 18 and 19, it would only be necessary to change the horizontal scale to read twice as many hours if the section is doubled and half as many hours if the section is divided in half, etc.

If the profiles and types of motive power are not similar, freight train performance charts and train hour diagrams offer convenient methods for analyzing the results which are obtained.

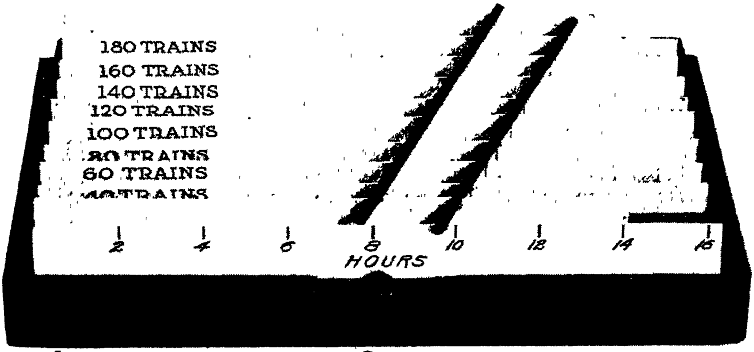


Fig. 20

Effect of Speed upon Freight Train Performance.—In the simple cases previously considered, it was assumed that all trains could be operated perfectly and all would make the same time assuming a given speed. Such a perfect performance as stated above can be represented by a rectangular train hour diagram. If the speed is increased the time of each train is reduced thus a change of speed from 10 m.p.h. to 12.5 m.p.h. makes a difference of two hours in a 100 mile run for each train. The effect upon the rectangular train hour diagram is to shorten the horizontal dimension an amount equivalent to the reduction in time, or two hours in the case assumed.

In actual cases all trains while they are assumed to be capable of making the same speed do not make the same time as seen by the actual train hour diagrams. It is assumed, however, that the train making the shortest time has been operated perfectly and therefore the effect of speed upon this train will be the same as in the theoretical case, that is, the time will be inversely proportional to speed.

In regard to all other trains it can be assumed that the actual effect of speed will be the same as the effect upon the perfectly operated train, because there is no reason for believing that the effect will be either greater or less

than in the theoretical cases. In other words, if the time of the train making the shortest time is reduced two hours, the time of all other trains will be reduced two hours. On this basis the shape of the actual train hour diagram will be unchanged except that the rectangular portion representing perfect operation is shortened along the horizontal axis an amount corresponding to the reduction in time or lengthened corresponding to an increase in time.

Referring to the model Fig. 18, if strips of uniform width equivalent to the reduction in time were blocked out from the left-hand edges of all the train hour diagrams, Fig. 17, the model would then represent the conditions corresponding to a given increase in speed. The same effect is obtained by laying a strip of the proper width over the left-hand edge of the model.

Likewise, if a strip of the proper width were laid over the left-hand end of the strips in Fig. 19, the model would show the freight train performance corresponding to a given increase in speed. The effect of a change of speed can be shown up clearer if a new set of guide cards for Fig. 19 are prepared on the basis of the shorter average time and inserted beside those in place. The punch marks in the new cards will appear in a straight line as indicated by the second rod inserted in the second set of grooves in Fig. 20. These two rods are parallel indicating that the effect of a change in speed upon freight train performance does not change the slope of the train performance line but only its position as determined by locating the point of intersection with the horizontal axis so that it will agree with the minimum time corresponding to the change in speed.

Log of Freight Train Performance.—The purpose of a log of freight train performance is to provide a simple means of comparing current month's operations with previous months' operations. This log usually consists of a tabulation of statistical data obtained from monthly reports supplemented by deriving certain averages which are plotted as explained below.

The derived data is plotted in two parts as shown in Fig. 21. In the upper part of the chart the average number of trains per day are plotted against the average hours per train. In the lower part the gross tons per day are plotted against the average hours per train. Thus in the upper part of the chart there will be twelve dots labeled or numbered to correspond to the months of the year. Each dot shows the average number of trains operated per day for the corresponding month and also the average time on the road for all trains, assuming the average run is equal to the distance between terminals.

In the lower part of the chart there will be twelve dots labeled or numbered to correspond to the months of the year, but instead of the dots showing the average number of trains per day, they show the average tonnage handled per day and the average time on the road per train. If the train weights were constant there would be no need for the lower portion of the chart because the upper and lower parts would be identical except for a difference in scale.

The upper part of the chart gives the same information as shown in model form Fig. 19. If the actual performance were according to theory a straight line could be drawn through all twelve points. Actually the 12 points for 1925 are not on a straight line but it is remarkable how close they come to a straight line. The point of intersection with the horizontal axis in this

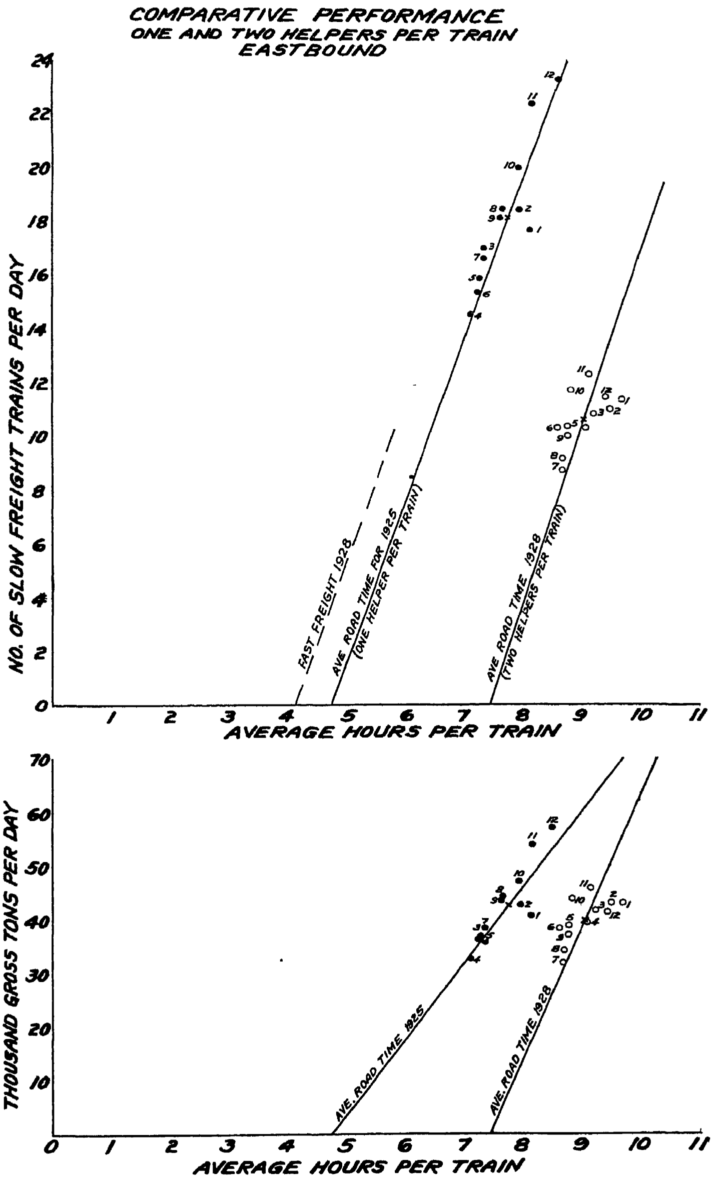

COMPARATIVE PERFORMANCE
ONE AND TWO HELPERS PER TRAIN
EASTBOUND
NO. OF SLOW FREIGHT TRAINS PER DAY
AVERAGE HOURS PER TRAIN
FAST FREIGHT 1928
AVE. ROAD TIME FOR 1925 (ONE HELPER PER TRAIN)
AVE. ROAD TIME 1928 (TWO HELPERS PER TRAIN)
THOUSAND GROSS TONS PER DAY
AVE. ROAD TIME 1925
AVE. ROAD TIME 1928
AVERAGE HOURS PER TRAIN

FIG. 21

case can be accurately determined from the position of the 12 points by laying a straight edge through the midst of the points, neglecting points 1 and 2. Having determined the point of intersection a line can be drawn through it and the point X which is the average performance for the year.

The twelve points for 1928 show quite a variation from a straight line, so much so as to leave considerable doubt in one's mind where a representative line would intersect the horizontal axis. For this reason a 10 day test period was selected and a train hour diagram, Fig. 22, constructed to determine the minimum time which will be seen is 7.45 hours. The straight line was then drawn through this time on the horizontal axis and the point X representing the average performance for the year.

These two lines show the effect of different methods of operation. The profile of the section of railroad where this data was obtained is such that one locomotive can handle on the light grades all the tonnage that four locomotives can handle on the heaviest grades. When only one helper locomotive is used on the heaviest grades the single locomotives are lightly loaded on the light grades and consequently can make higher speed than they can when more heavily loaded with a train which requires two helpers on the heaviest grades.

Theoretically these two lines should be parallel. As drawn they are not parallel but it would require only a slight adjustment to make them parallel. The dotted line represents the performance of fast freight trains as obtained from train hour diagram, Fig. 23. All three lines are nearly parallel as called for by the theory.

This log of freight train performance indicates that while it required about eighteen trains with a single helper to handle 42,500 gross tons per day in 1925, it required less than eleven trains with two helpers to handle 39,500 gross tons per day in 1928, or the number of trains required to handle a given tonnage is about inversely proportional to the number of locomotives per train as would be expected, but the average time on the road is 1.4 hours shorter (not withstanding the greater number of trains) when only one helper is used than when the train weight is increased and two helpers per train are used.

Comparative Freight Train Performance Charts.—In order to show the effect of additions and betterments, such as double tracking, grade revisions, signals or larger motive power, it is often instructive to construct comparative freight train performance charts by plotting the average points from the log of freight train performance for a year or number of years prior to the date of the given improvements for comparison with the performance after the improvements have been made. In other words, these charts help to analyze what has been accomplished and by what means; hence, in looking ahead they can be used for forecasting what may be accomplished by various kinds of improvements.

An interesting chart of this kind is shown in Fig. 24 for railways in the United States compiled from periodic reports of the Interstate Commerce Commission. The dots on this chart show the average freight train performance for nine years, 1921-1929. The sloping lines are obtained from the log of freight train performance (not shown) to assist in explaining the use which can be made of the charts.

It will be noted that with the exception of 1922, all the dots for the five year period between 1921 and 1926 fall between the two sloping lines, and

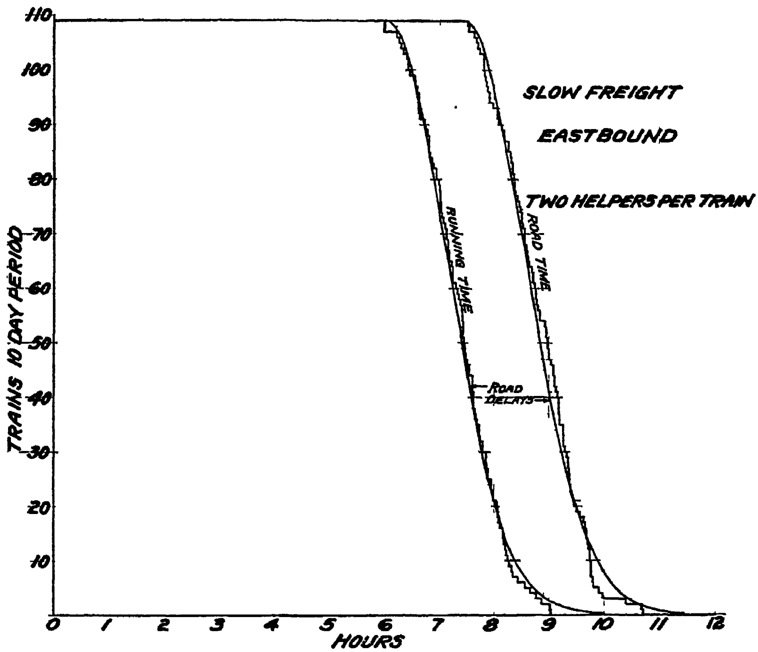

SLOW FREIGHT
EASTBOUND
TWO HELPERS PER TRAIN
RUNNING TIME
ROAD TIME
ROAD DELAYS
TRAINS 10 DAY PERIOD
HOURS

FIG. 22

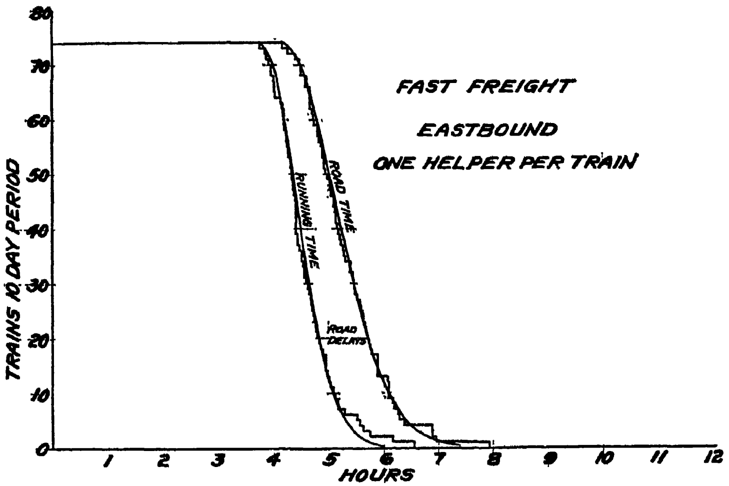

FAST FREIGHT
EASTBOUND
ONE HELPER PER TRAIN
RUNNING TIME
ROAD TIME
ROAD DELAYS
TRAINS 10 DAY PERIOD
HOURS

FIG. 23

none of the dots for later years falls within this area. The reason for the 1922 dot falling below the 1921 line is explained by the fact that the shopmen's strike and fuel shortage occurred in that year. The dot for every other year is above the 1921 line indicating that the trend in freight train performance may be represented by revolving the sloping line about its intersection with the horizontal axis in a counter-clockwise direction. Thus freight train performance has been improving consistently for the past eight years.

The improvements in performance from year to year are due in a large measure to the large investments the railroads have made during this period for new facilities. During the eight year period from 1921 to 1929, the railroads have invested in road and equipment upwards of 800 million dollars per year and have retired property amounting to over 200 million dollars per year, leaving a net investment of nearly 600 million dollars per year, a large part of which represents new facilities. By means of these new facilities the railroads have been able to handle 50 per cent more traffic in 1929 than they handled in 1921, and shorten the time on the road 14 per cent. The freight train miles have increased 15.5 per cent indicating that the average weight of trains has increased 30 per cent. The effect of these investments shows up in the record of freight train performance and also in increased revenues and lower operating costs.

Judging from the past and looking ahead 10 to 15 years, the railroads will be called upon to invest many millions of dollars more for new facilities. If the traffic should increase 40 per cent, the weight of trains 20 per cent, and the speed 10 per cent, it is a simple matter to show on the diagram what the performance will be at that time. The point "A" indicates graphically the effect of these conditions upon freight train performance and it will be interesting to follow the records and note the progress from year to year with reference to this point.

The results obtained by all the railroads in the United States, ten to fifteen years from now, will be a combination of the results obtained on individual systems, and the system results will be a combination of the results obtained on the divisions composing the system. The past performance on individual districts or divisions can be analyzed by means of Freight Train Performance Charts and the analyses used to investigate various methods by which increased capacity can be obtained, a better service performed and operating costs reduced.

Applications

Freight Train Performance charts or Train Hour Diagrams have been used in the following studies:

(1) Forecast of the effect of double tracking upon freight train performance compared with actual results. A.R.E.A. Proceedings, Vol. 24, page 1046—Vol. 27, page 746—Vol. 30, page 752.
(2) Effect of passenger train operation upon freight train performance, A.R.E.A. Proceedings, Vol. 25, page 708.
(3) Effect of supervision upon freight train performance, A.R.E.A. Proceedings, Vol. 26, page 878.
(4) Effect of substituting heavy steam power for light steam power upon freight train performance, A.R.E.A. Proceedings, Vol. 26, page 878.
(5) Effect of the installation of automatic signals upon freight train performance, A.R.E.A. Proceedings, Vol. 27, page 739, Vol. 31, page 1003.

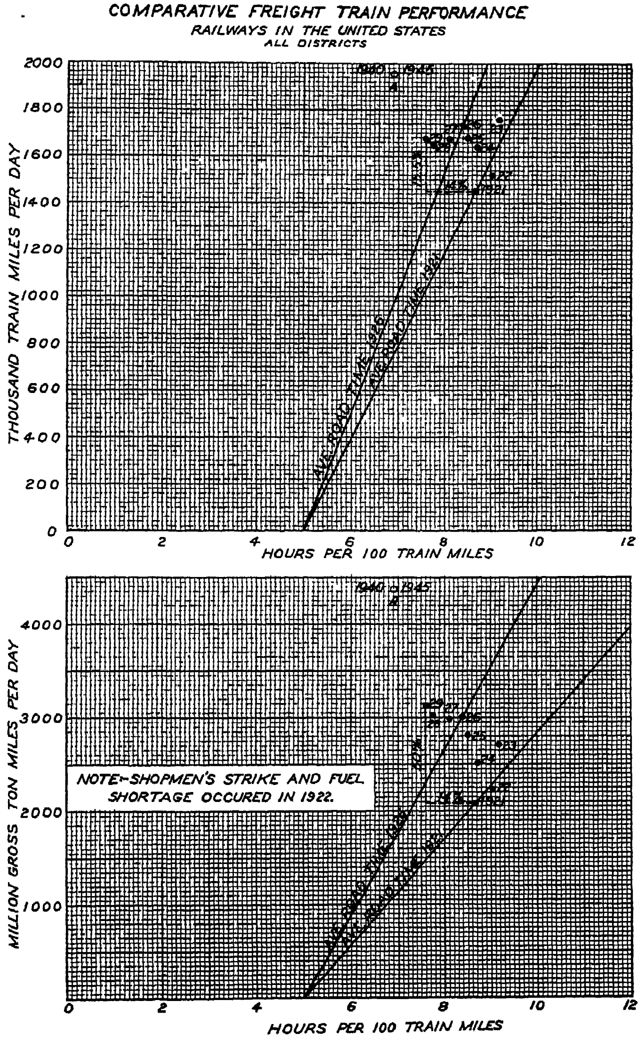

COMPARATIVE FREIGHT TRAIN PERFORMANCE
RAILWAYS IN THE UNITED STATES
ALL DISTRICTS
THOUSAND TRAIN MILES PER DAY
HOURS PER 100 TRAIN MILES
AVE. ROAD TIME 1926
AVE. ROAD TIME 1921
MILLION GROSS TON MILES PER DAY
NOTE:- SHOPMEN'S STRIKE AND FUEL SHORTAGE OCCURED IN 1922.
HOURS PER 100 TRAIN MILES

FIG. 24

A

SUMMARY

Freight Train Performance—Railways in the United States—All Districts

Year	*1000 Freight Train Miles*	*Million Gross Ton Miles Excl. Loco.*	*Train Hours*	*1000 Frt. Train Miles Per Day*	*Million Gross Ton Miles Per Day*	*Hours Per 100 Train Miles*
1921	530,141	760,716	45,949,610	1,452	2,084	8.67
1922	554,780	813,052	50,148,349	1,520	2,227	9.04
1923	641,556	987,384	58,885,148	1,758	2,705	9.18
1924	600,576	953,968	52,239,512	1,640	2,605	8.71
1925	612,865	1,023,490	52,010,380	1,679	2,805	8.49
1926	632,557	1,098,692	53,064,819	1,733	3,010	8.39
1927	610,497	1,086,829	49,525.815	1,673	2,978	8.11
1928	601,648	1,105,506	46,740,784	1,644	3,021	7.77
1929	611,919	1,141,619	46,496,855	1,676	3,128	7.60
1930						
1940 to 1945	714,000	1,598,000	49,266,000	1,957	4,379	6.90

SUMMARY

Effect of Double Tracking

One of the first applications made of the theoretical train hour diagram and freight train performance chart was in connection with a study to forecast the effect of double tracking a short section of road on an important trunk line. See Vol. 24, page 1046. Later the section was double tracked and a second study was made to compare the forecast with the results actually obtained. See Vol. 27, page 746.

In another study train hour diagrams and freight train performance charts were used to show the effect of major improvements on a line 122 miles long. These improvements consisted for the most part of an increase in double track from 43 miles to 101 miles, or nearly two and a half times. Some reductions were made in the ruling grades and yard facilities were improved. The total effect is shown in Fig. 25, reprinted from the Proceedings, Vol. 30, page 752. In this case the actual results would have been difficult to forecast unless a more detail study were made of the conditions existing in 1924 to ascertain the causes for road delays affecting the performance of the best or assumed perfectly operated train.

The improvement in the performance of fast freight trains between 1924 and 1926 as shown on the freight train performance chart are approximately what would be expected from the additional double track, but the improvement in the performance of slow freight trains is much greater than can be accounted for by the additional amount of double track. No doubt the double track improvement corrected other faults and for this reason a large part of the improved train performance may be due to the correction of unfavorable conditions aside from double tracking.

Effect of Passenger Train Operation upon Freight Train Performance

The principle of freight train performance charts was used in a study published in Vol. 25, page 708, to show the effect of passenger train operation upon freight train performance. The data indicated that the effect of adding three passenger trains per day was equivalent to the effect of adding five freight trains, or that one passenger train is nearly equivalent to two freight trains in its effect upon the performance of freight trains.

From this relation it will be seen that passenger train operation is an important factor to be taken into consideration when dealing with the actual track capacity of a railroad.

Effect of Supervision

Supervision is a factor which has a more or less intangible effect upon freight train performance. On account of the fact that it is difficult to evaluate it is ordinarily assumed to be constant and is neglected.

It is generally understood that supervision has to do with those factors affecting morale, working conditions or direction of the employees. The effect of these factors upon train performance depends to a large extent upon the degree that this function is exercised. It is made manifest only periodically when an extra effort is made to achieve better results, or when conditions arise which render it ineffective.

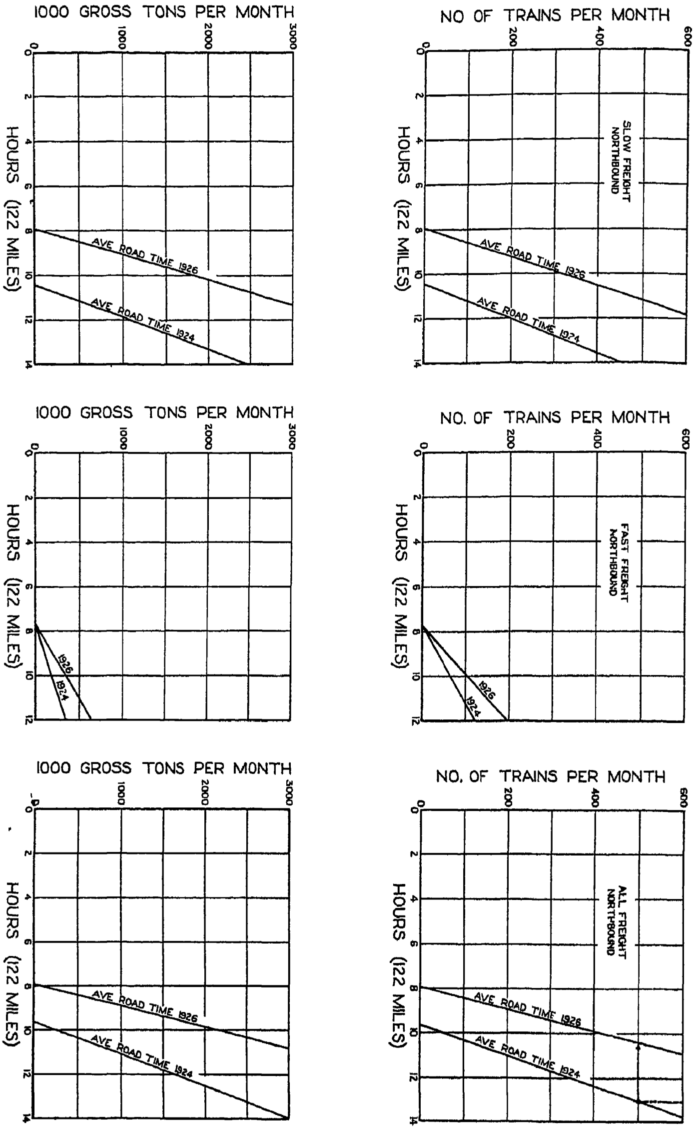


FIG. 25—TRAIN PERFORMANCE ON 122-MILE SECTION DERIVED FROM TRAIN HOUR DIAGRAMS NORTHBOUND TRAINS JUNE, 1924 AND 1926, BEFORE AND AFTER DOUBLE TRACKING.

To illustrate, it will be recalled that the strike of union coal miners in April, 1922, was later followed by the shopmen's strike in July. A fuel shortage resulted from the former and supervision was rendered ineffective by the latter. Freight train performance charts offer a convenient way to compare the freight train performance for the ten months' period, beginning with July, 1922, and ending with April, 1923, with a 31 months' period when conditions were normal. See Vol. 26, page 886. These were extreme conditions and probably there would be few cases where supervision could be expected to have as great an influence as indicated in this case. It indicates, however, that the gain from intelligent supervision may be as effective as large expenditures for new facilities.

Effect of Substituting Heavy Steam Power for Light Steam Power upon Freight Train Performance

Freight train performance charts were used to show the effect of a change in the capacity of steam locomotives upon freight train performance. The study was published in Vol. 26, page 886, and is largely qualitative. No attempt was made to analyze the results so as to be able to use them in forecasting what can be accomplished by substituting heavier power by comparing the characteristics of the locomotive.

Effect of Installing Automatic Signals

Freight train performance charts were used to show the effect of installing automatic signals on two sections of a single track division. The studies were published in Vol. 27, page 739. Fig. 26 shows the results of signal installation on a forty-two mile section. This installation resulted in a reduction of thirty-one minutes in the average road time per train corresponding to an apparent gain in tonnage capacity of 37.8 per cent.

The installation on a sixty-six mile section resulted in a reduction of one hour and four minutes in the average road time per train corresponding to an apparent gain in tonnage capacity of 55.0 per cent as shown in Fig. 27.

A third installation described in Vol. 29, page 442, was made on a forty-eight mile section and resulted in a reduction of twenty-five minutes in the average road time corresponding to an apparent gain in tonnage capacity of 35 per cent as shown in Fig. 28.

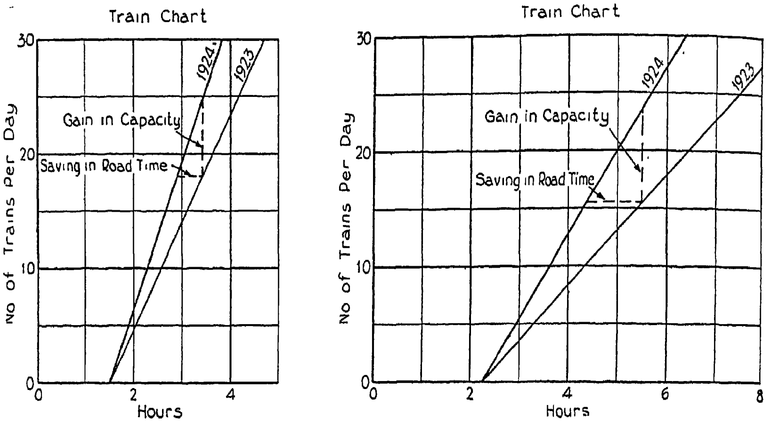
In connection with each of these installations a change was made from No. 31 to No. 19 train orders. The improvements in train performance are partly due to this change in the manner of issuing train orders.

Effect of Installing Dispatcher Control or Central Control System

The installation on which this study was made is known as the first complete instance of signal dispatching whereby trains operated by signal indication on single track without train orders or time table superiority.

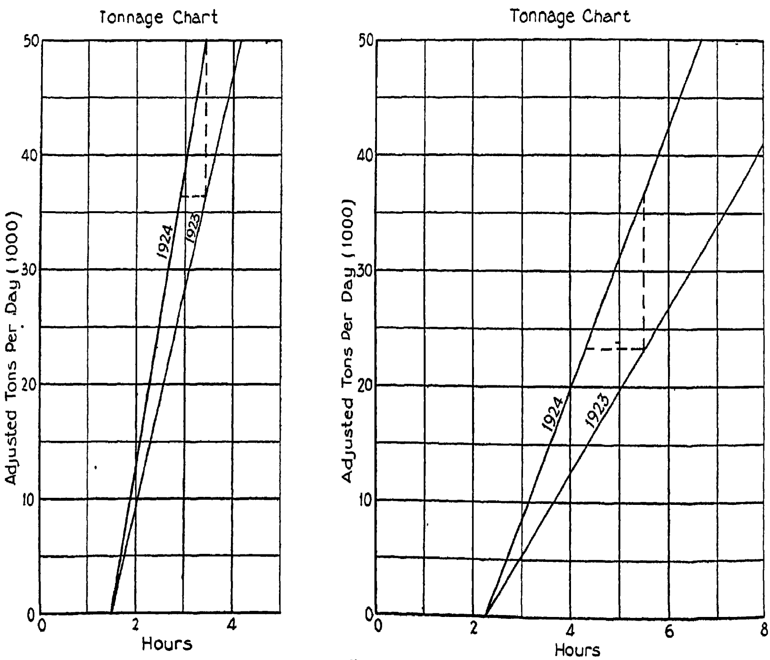
The installation covers forty miles of road, of which 37 miles is single track and 3 miles double track signalled in both directions, or the equivalent of forty-three miles of single track signalling.

The study was published in Vol. 31, page 1003.



Train Chart
No of Trains Per Day
Hours
Gain in Capacity
Saving in Road Time
1924
1923
Train Chart
No of Trains Per Day
Hours
Gain in Capacity
Saving in Road Time
1924
1923

FIG. 26



Tonnage Chart
Adjusted Tons Per Day (1000)
Hours
1924
1923
Tonnage Chart
Adjusted Tons Per Day (1000)
Hours
1924
1923

FIG. 27

Conclusions

A. (1) It has been found that train operations can be represented by a mathematical law.

(2) The application of this law to different sets of observations make it possible to compare several months' operation of a given division on a more equal basis. Likewise, operations of different divisions which are more or less similar can be compared on more nearly the same basis.

(3) By such comparisons the effect of extreme weather conditions, greater facilities, motive power, different commodities, and supervisory methods on the average time on the road can be more accurately determined.

B. (1) Increased supervision, consisting of scientific study and thoughtful effort, will increase the capacity of a railway.

(2) Increasing capacity of locomotives results in an equal increase in capacity of the railway.

(3) Double tracking will increase the capacity of a railway. The increase in capacity being proportional to the amount of second track. Careful study should be given to practicability of increasing capacity of single track and obtaining more intensive use of same, either by increased supervision and study of operations, signals, etc., before constructing double track.

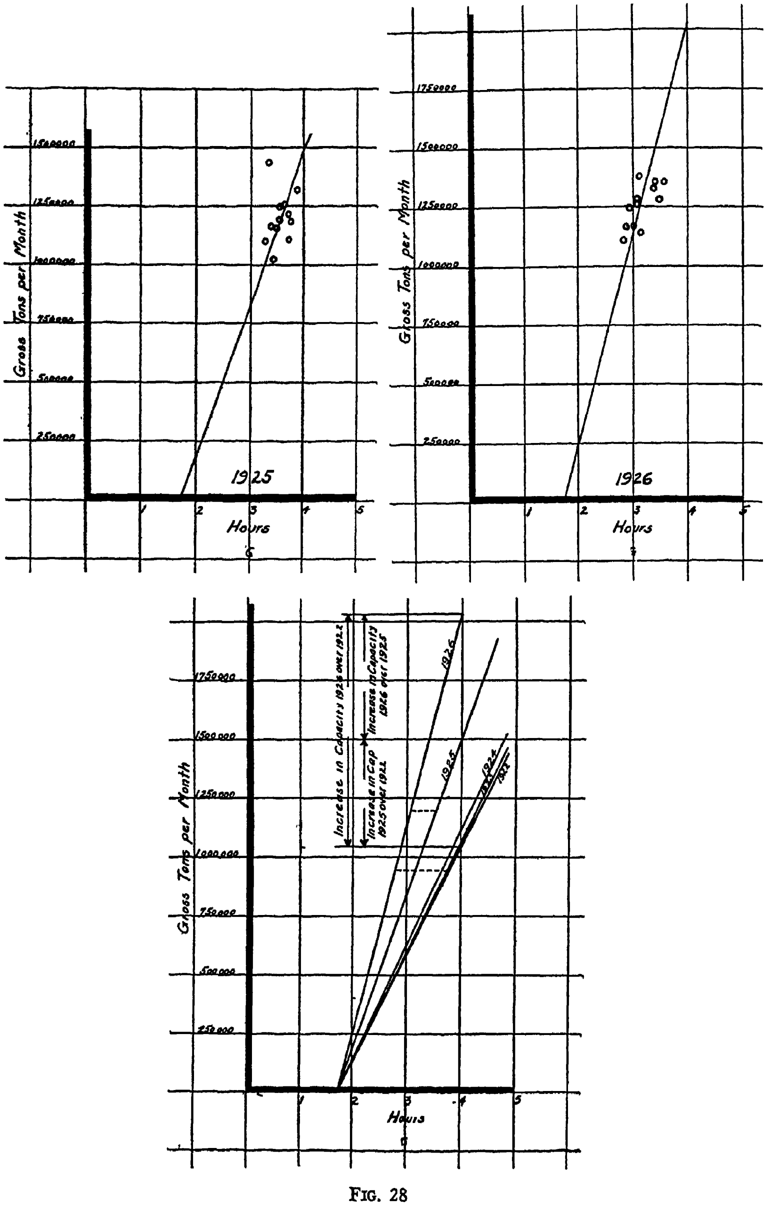
(4) Installation of automatic signals on a single-track railway will increase the capacity of the road, this increase varying with the length of division on which installed and with the number of passenger trains operated.

(5) Installation of Complete Signal Dispatching System on a single-track railroad will increase the capacity of the road. This method of increasing capacity should be considered when the volume of traffic justifies, or when other conditions necessitate.

These studies have been undertaken to test out the theory of train hour diagrams and obtain experimental knowledge which would serve to extend the scope of the method in connection with the investigation of other factors relating to freight train operation.

From a qualitative standpoint, comparative freight train performance charts provide a simple and accurate method for showing actual results obtained by various methods of operation or changes in facilities. In order to analyze the results or forecast the effect of proposed improvements, it is necessary to develop a mathematical theory to account for some of the relations which have been found to exist. A discussion of the mathematical theory will be found in Exhibit A.

The Committee recommends that this report be received with the view of having it prepared for presentation and publication in the Manual.



Gross Tons per Month
1500000
1250000
1000000
750000
500000
250000
1925
1 2 3 4 5
Hours
Gross Tons per Month
1750000
1500000
1250000
1000000
750000
500000
250000
1926
1 2 3 4 5
Hours
Gross Tons per Month
1750000
1500000
1250000
1000000
750000
500000
250000
Increase in Capacity 1926 over 1922
Increase in Capacity 1926 over 1925
Increase in Cap 1925 over 1922
1926
1925
1924
1922
1 2 3 4 5
Hours

FIG. 28

Exhibit A

SIMILARITY BETWEEN THE TYPICAL TRAIN HOUR DIAGRAM AND PROBABILITY CURVE

Train operations have in them the element of luck, that is, every train after it leaves a terminal runs a chance of being delayed from one cause or another. Some trains will be delayed more than others and the time that a train consumes on the road depends largely upon various combinations of circumstances. It is, therefore, logical to assume that an equation in the form of the Probability Curve will most nearly fit the points on the train hour diagram.

When the origin of co-ordinates is (0,0) the equation of the Probability Curve is:

$$Y = Ke^{-(nx)^2}$$

which is symmetrical both sides of the Y axis as shown in Fig. 29. By using half of the probability curve and substituting a rectangle for the other half, the typical train hour diagram is obtained as indicated. In this connection it is interesting to note how closely the theoretical values obtained from the equation agree with the actual values obtained from dispatcher sheets. See train hour diagrams of road time and crew time Fig. 16, also Fig. 22 and 23.

Two points, a and b, on each diagram can be used to derive the equation of the probability curves and compute the theoretical values.

(I) Derivation of Theoretical Train Hour Diagram

Let the equation of the theoretical train hour curve be

$$Y = Ke^{-(nt)^2}$$

Where $Y =$ Number of trains taking more than t hours to complete their runs.

$K =$ a constant.

$t =$ hours referred to a system of co-ordinates where $Y = K$ when $t = o$.

Then if K is known the co-ordinates of two other points (a and b) will determine the curve. The number of trains considered determines K, hence if

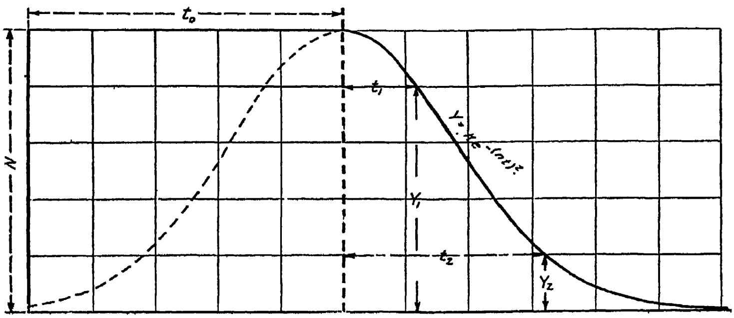


FIG. 29

(Y_1, t_1) and Y_2, t_2) are the co-ordinates of the two points a and b respectively, then

$$Y_1 = Ke^{-(nt_1)^2} \quad and \quad Y_2 = Ke^{-(nt_2)^2}$$

$$\text{or } (nt_1)^2 = log_e \left(\frac{K}{Y_1}\right) \quad and \quad (nt_2)^2 = log_e \left(\frac{K}{Y_2}\right)$$

Substituting $t_1 + C$ *for* t_2

$$n_2 (t_1 + C)^2 = log_e \left(\frac{K}{Y_2}\right)$$

Solving for t_1 and n

$$t_1 = \frac{C}{\sqrt{M - 1}} \qquad where\ M = \frac{log_e \left(\frac{K}{Y_2}\right)}{log_e \left(\frac{K}{Y_1}\right)}$$

$$n_2 = \frac{log_e \frac{K}{Y_1}}{t_1^2}$$

If t_1' and t_2' are the abscissae of the points a and b, and t_0 the abscissa of the origin of the assumed system of co-ordinates when referred to the origin of the train hour diagram, then

$t_1' - t_1 = t_0 =$ the minimum time

The following table shows a convenient arrangement of the calculations for obtaining the equations of the theoretical train hour diagrams and plotting the curves. N representing the number of trains has been substituted for K, a constant in the formula.

TABLE

		Example
1. Total Number of Trains Considered....	N	100
*2. No. of Trains over t_2' Hours (8.2)......	Y_2	20
*3. No. of Trains over t_1' Hours (6.2).....	Y_1	80
4. Time Interval Between t_2' and t_1'......	C	2
5. Ratio Item (1)/Item (2) $= \frac{N}{Y_2}$		5
6. Ratio Item (1)/Item (3) $= \frac{N}{Y_1}$		1.25
7. Loge Item (5)		1.60944
8. Loge Item (6)		.22314
9. Ratio Item (7)/Item (8)	M	7.213
10. Square Root Item (9)		2.685
11. Item (10) — 1		1.685
12. Item (4) + Item (11)	t_1	1.187
13. t_1' of Item (3) — Item (12)............	t_0	5.013
14. Item (8) ÷ Item (12)² (See note §)...	n^2	.1584
15. Square Root Item (14)	n	.398
T (theoretical) $= t_0 + \frac{\sqrt{\pi}}{2n}$		7.238

*To obtain accuracy Y_2 and Y_1 should be selected so that the ratios N/Y_2 and N/Y_1 will be approximately 1.25 and 5.0 respectively.

$t' = t_0 + t$	t_0	t	$(nt)^2$ Item $14 \times t^2$	$e^{-(nt)^2}$ Note A	$ne^{-(nt)^2}$
5.013	5.013	0.0	0	1.000	100.0
5.513		5	.0398	.960	96.0
6.013		1.0	.1584	.870	87.0
7.013		2.0	.6336	.528	52.8
8.013		3.0	1.4256	.240	24.0
9.013		4.0	2,5344	.080	8.0
10.013		5.0	3.9800	.020	2.0
11.013		6.0	5.7024	.003	.3

Note A.—For convenience the values of $e^{-(nt)^2}$ are shown by curve A, Fig. 30, for various values of $(nt)^2$.

§ If common logs are used in the calculations multiply item 14 by 2.30.

(II) Area of the Theoretical Train Hour Diagram

The area of the train hour diagram is the sum of two areas, one the area of a rectangle having the dimension N and t_0 and the other the area under half the probability curve. If the area under the probability curve between 0 and ∞ is taken as unity, it can be shown that

$$K = \frac{2n}{\sqrt{\pi}} = N$$

Hence, the area of the train hour diagram referred to some arbitrary unit of area is

$$Nt_o + 1 = \frac{2\ n\ t_o}{\sqrt{\ \pi}} + 1$$

$$Nt_o = \frac{2\ n\ t_o}{\sqrt{\ \pi}} \quad \text{or} \quad \frac{N\ \sqrt{\pi}}{2n} = 1$$

or the area of the train hour diagram in train hours is

$$Nt_o + \frac{N\ \sqrt{\pi}}{2n}$$

and the average time $T = t_o + \dfrac{\sqrt{\pi}}{2n}$

Substituting $\dfrac{\sqrt{\pi}}{2n}$ for t in the formula $Y = Ne^{-(nt)^2}$

$$Y = Ne^{-\frac{\pi}{4}} = .456\ N$$

In other words, 45.6 per cent of the trains will consume more than the average time and 54.4 per cent of the trains will consume less than the average time.

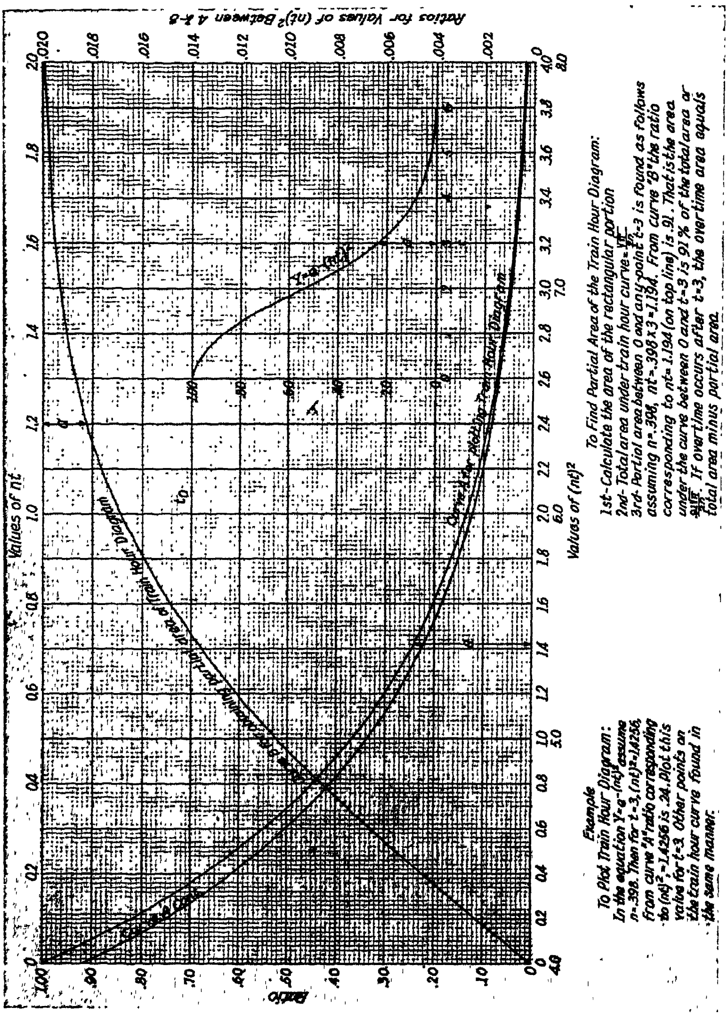

Ratios for Values of (nt)² Between 4 & 8
Values of nt
Values of (nt)²
Ratio
Y=e^-(nt)²
Curve B for Obtaining Partial Area of Train Hour Diagram
Curve A for Plotting Train Hour Diagram
To Find Partial Area of the Train Hour Diagram:
1st-Calculate the area of the rectangular portion
2nd-Total area under train hour curve = √π/2n
3rd-Partial area between 0 and any point t=3 is found as follows assuming n=.398, nt=.398×3=1.194. From curve "B" the ratio corresponding to nt=1.194 (on top line) is .91. That is the area under the curve between 0 and t=3 is 91% of the total area or .91√π/2n. If overtime occurs after t=3, the overtime area equals total area minus partial area.
Example
To Plot Train Hour Diagram:
In the equation Y=e^-(nt)² assume n=.398. Then for t=3, (nt)²=1.4256, from curve "A" ratio corresponding to (nt)²=1.4256 is .24. Plot this value for t=3. Other points on the train hour curve found in the same manner.

Fig. 30.

(III) Area of the Theoretical Crew-Expense Diagram

If crews are paid on the basis of 100 miles or eight hours, all crews will be paid for a minimum of eight hours (if the run is not over 100 miles) and crews on duty more than eight hours will make overtime. Usually some of the crews will be on duty less time than the limit set for overtime to begin. If t'' (AE Fig. 14) represents the time when overtime begins, then the area of the rectangle (AEFD) having the dimensions N and t'' will represent the hours paid for at straight time rates. The area of that part of the train hour diagram outside of the rectangle represents overtime and is paid for at overtime rates which are usually higher than the straight time rates. In the United States the overtime rates are 50 per cent higher than the straight time rates.

If all crews make overtime the difference between the total time on duty and the total straight time equals the total overtime. If some crews are on duty less hours than the straight time pay calls for it is necessary to calculate the total overtime as described below.

It will be seen from the diagrams that the area representing overtime is only part of the area under the probability curve. By assuming arbitrary units the total area under the probability curve can be made equal to unity and the area of any portion can be expressed as a decimal or as a ratio. Curve B, Fig. 30, has been plotted from tables giving values of the probability integral corresponding to various values of (nt) and shows the ratio of the area under the probability curve between o and t to the total area under the curve. The difference between the total area and the area between t_0 and t'' represents the overtime, or the ratio of the overtime to the total area under the probability curve is equal to one minus the ratio found from curve B.

Example. Find the area of the crew expense, diagram Fig. 30 and Fig. 16.

	Fig. 30	Fig. 16
1. Number of Trains ....N....	100	141
2. Hours when Overtime begins............t''....	8.000	12.00
3. Minimum Time on Duty ....t_0....	5.013	10.88
4. $t'' - t_0 = t$	2.987	1.12
5. n (calculated)	.389	.291
6. nt	1.189	.346
7. Ratio from Curve B for (nt)................	.909	.375
8. 1—Item (7)	.091	.625
9. $\sqrt{\pi} \div 2n$	2.225	3.015
10. Item (8) $\times$ Item (9)......................	.203	1.884
11. Total Overtime Item (1) $\times$ Item (10)........	20.30	265.6
12. Punitive Overtime ½ Item (11)..............	10.15	132.8
13. Straight Time Item (1) $\times$ Item (2)..........	800.00	1692.0
14. Hours Paid for Items (11) + (12) + (13).....	830.45	2100.4
15. Hours on Duty	723.80	1959.2

(IV) Effect of Various Operating Conditions Upon Dimensions of Train Hour Diagrams

Having determined freight train performance for a known set of operating conditions it would be useful if some way were found to forecast what the performance would be under different operating conditions. Assuming that theoretical train hour diagrams can be calculated which will closely

approximate the actual train hour diagrams then by comparison of the mathematical relationship it ought to be possible after some experience to calculate the theoretical train hour diagrams for various operating conditions by substituting different values in the equation of the train hour curve.

Suppose that Fig. 16 is the train hour diagram obtained from a division M_1 miles long operating N_1 trains per day and it is desired to ascertain what the performance will be if the length of the division is changed to M_2 miles the number of trains increased to N_2 trains per day and the speed increased from S_1 to S_2, other conditions remaining constant.

If all trains could be operated perfectly, which is the limiting case, the train hour diagrams for all conditions would be rectangles with various dimensions. Increasing the length of the division without changing the number or speed of trains would increase the time on the road and hence lengthen the train hour diagram along the horizontal axis. Increasing the number of trains per day without changing the length of division or speed of trains would only increase the height of the train hour diagram, and increasing the speed of trains without changing the length of division or number of trains would decrease the length of the train hour diagram. The final effect of changing all the conditions can be found by analyzing the effect of each condition and combining the results.

In actual cases there are numerous conditions which affect freight train performance with the result that the train hour diagram is no longer a rectangle but is made up of two parts, one part being a rectangle and the other part being more or less triangular in shape. The rectangular portion of the train hour diagram represents perfect operation, assuming that the train taking the shortest time was operated perfectly as compared with other trains. Trains which did not operate as well as the best, met with conditions which delayed them. So far as can be ascertained all trains were capable of making the same speed and except for incidental occurrences which happen to some trains and not to others or in greater degree to some trains than to others, the time on the road would be the same for all trains. The delays due to incidental occurrences are governed by conditions on the road, for example, the incidental occurrences on double track would be fewer and would cause less delay than the incidental occurrences on single track, likewise signals and careful dispatching of trains accomplish similar results.

The effect of changes in conditions of the character mentioned above must be determined experimentally for a number of cases to obtain data which can be used in making forecasts. It is possible however to calculate theoretically the effect of changing the length of division, or number of trains per day or the speed of trains upon the equation of the train hour curve. The following mathematical discussion has been prepared in order to correct for slight differences in these conditions when comparing the performances at different periods.

(V) Effect of Length of Division Upon Freight Train Performance

Assume that N_1 represents the number of trains operated over a division M_1 miles long during a selected period; t_0, the minimum time and T_1 the average time and it is desired to know what the change in these factors would be if the division were increased to M_2 miles.

If there were no change in speed of trains the minimum time representing perfect operation would be increased in the ratio of the lengths of divisions.

$$t'_o = \frac{M_2}{M_1} \times t_o$$

Likewise if the character of the profiles and track arrangement are equivalent the incidental occurrences causing delays would be equal in equal distances or proportional to the distances traveled. Hence the average time

$$T_2 = \frac{M_2}{M_1} \times T_1$$

$$\text{or } t'_o + \frac{\sqrt{\pi}}{2n_2} = \frac{M_2}{M_1}\left(t_o + \frac{\sqrt{\pi}}{2n_1}\right)$$

$$n_2 = \frac{M_1}{M_2} n_1$$

Thus it is possible to calculate the theoretical train hour diagram corresponding to a change in length of division other conditions remaining constant.

(VI) Effect of Number of Trains Upon Freight Train Performance

If N_1, T_1 and t_0 are the dimensions of a train hour diagram obtained during a period when N_1 trains were operated and it is desired to construct a theoretical train hour diagram for another period when N_2 trains will be operated, the equation of the curve can be obtained as follows:

If there is no change in speed the minimum time representing perfect operation will be the same for N_2 trains as for N_1 trains.

$$t_0' = t_0$$

If the occurrences causing delays to trains going the same distance are proportional to the number of trains the areas under the curve portions of the train hour diagrams are similar figures, that is, the areas will be proportional to the square of their linear dimensions.

$$\frac{N_2 \dfrac{\sqrt{\pi}}{2n_2}}{N_1 \dfrac{\sqrt{\pi}}{2n_1}} = \left(\frac{N_2}{N_1}\right)^2$$

$$\text{or } N_1 \frac{\sqrt{\pi}}{2n_2} = N_2 \frac{\sqrt{\pi}}{2n_1}$$

$$n_2 = \frac{N_1}{N_2} n_1$$

$$T_2 = t_o + \frac{\sqrt{\pi}}{2n_2} = t_o + \frac{\sqrt{}}{2\frac{N_1}{N_2}n_1}$$

$$T_2 = t_o + \frac{N_2}{N_1} \times \frac{\sqrt{\pi}}{2n_1} = \text{equation of a straight line.}$$

When $N_2 = 0$ $T_2 = t_o$

Thus the effect of increasing the number of trains may be represented by a straight line which intersects the horizontal axis at a point corresponding to the minimum time t_o. See freight train performance charts and log of freight train performance, Fig. 21 and 24.

Hence given a freight train performance chart the equation of the theoretical train hour diagram can be computed for any number of trains from the average time and minimum time as follows:

$$T = t_o + \frac{\sqrt{\pi}}{2n}$$

$$\text{Hence } n = \frac{\sqrt{\pi}}{2(T - t_o)}$$

(VII) Effect of Speed Upon Freight Train Performance

If N_1, T_1 and t_o are the dimensions of a train hour program obtained when the speed of trains was S_1 and it is desired to construct a theoretical train hour diagram for another period when the speed of trains will be S_2 the equation of the curve can be obtained as follows:

If the speed of trains is increased from S_1 to S_2 the minimum times t_o and t_o' representing perfect operation will be inversely proportional to the speeds.

$$t_o = \frac{S_1}{S_2} \times t_o$$

$$\text{or } t_o - t'_o = \frac{S_2 - S_1}{S_2} \times t_o$$

If the reduction in time $(t_o - t_o')$ due to increase in speed is the same for all the trains operated during a given period, there will be the same difference in the average time or

$$T_1 - T_2 = \frac{S_2 - S_1}{S_2} \times t_o$$

$$\text{or } t_o + \frac{\sqrt{\pi}}{2n_1} - \left(t_o + \frac{\sqrt{\pi}}{2n_2}\right) = \frac{S_2 - S_1}{S_2} \times t_o$$

$$n_2 = n_1$$

$$T_1 = t_o + \frac{N_2\sqrt{\pi}}{2N_1 n_1} \text{ and } T_2 = t'_o + \frac{N_2\sqrt{\pi}}{2N_1 n_1} \text{ are equations}$$

of two parallel straight lines.

Since incidental occurrences are assumed to be governed by conditions on the road they are independent of speed and hence the assumption that $T_1 - T_2 = t_0 - t_0'$ and not greater or less than $t_0 - t_0$ is the only assumption which can logically be made. Fig. 21 shows an actual case which agrees substantially with the theory.

(VIII) Effect of Double Track Upon Freight Train Performance

Double tracking increases the track capacity and theoretically reduces the incidental occurrences which cause delays in proportion to the increased track capacity. Theoretically perfect performance on single track is the same as perfect performance on double track, hence if T_1 and T_2 represent the average time for single and double track operation respectively.

$$T_o = t_o + \frac{\sqrt{\pi}}{2n_1} \text{ and } T_2 = t_o + \frac{\sqrt{\pi}}{2n_2}$$

If C_1 and C_2 represent the relative capacities for single and double track the average delays due to incidental occurrences represented by the second term will be inversely proportional to the relative capacities, or

$$\frac{\sqrt{\pi}}{2n_2} = \frac{C_1}{C_2} \times \frac{\sqrt{\pi}}{2n_1}$$

$$\text{or } n_2 = \frac{C_2}{C_1} \times n_1$$

$$\text{From } VI\ n'_2 = \frac{N_1}{N_2} \times n_2 = n_1 = \frac{C_1}{C_2} \times n_2$$

$$\text{or } \frac{N_2}{N_1} = \frac{C_2}{C_1}$$

That is for a given average time the number of trains which can be operated without exceeding the given time varies directly with the track capacity.

In actual practice perfect performance on double track is often better than perfect performance on single track, because of the fact that on single track a train may never be found that actually had a clear track with no interference.

(IX) Effect of Signals Upon Freight Train Performance

The installation of signals or improvements in dispatching theoretically reduces the incidental occurrences which cause delays without adding track capacity. The effect therefore is similar to double tracking but the saving in delays is less than for double tracking and since there is no increase in track capacity the number of trains which can be operated is limited by the track capacity as shown in Fig. 31.

(X) Miscellaneous

The foregoing discussion outlines the effect of some of the fundamental conditions upon freight train performance. Grade revision, new alignment, supervision, substitution of more powerful motive power, etc., have indirect effects upon the fundamental conditions. When these effects are known the

fundamental conditions can be corrected accordingly and a forecast made of what the results will be. If the effects are unknown it is possible by comparing the performance at different periods and correcting for variations in the fundamental conditions to segregate the unknown effect, and investigate the conditions which may have caused it.

The most concise method for showing the actual performance or the effect of improvements in facilities is by means of the Monthly Log of Freight Train Performance or by the Yearly Freight Train Performance Chart.

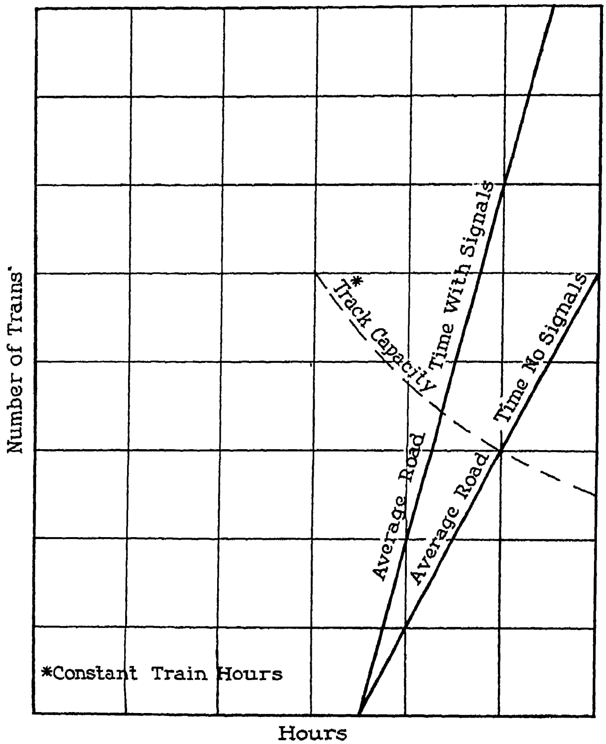


FIG. 31

Appendix B

(3) METHODS OR FORMULAS FOR THE SOLUTION OF SPECIAL PROBLEMS RELATING TO MORE ECONOMICAL AND EFFICIENT RAILWAY OPERATION

E. M. Hastings, Chairman, Sub-Committee; B. T. Anderson, R. C. Bardwell, S. B. Cooper, W. J. Cunningham, J. M. Farrin, W. W. Judson, F. H. McGuigan, Jr., H. T. Porter, V. I. Smart, M. F. Steinberger, B. Wheelwright and C. C. Williams.

VOLUME OR OTHER CONDITIONS OF BUSINESS OR SERVICE THAT WILL JUSTIFY A CHANGE FROM FLAT SWITCHING TO THE HUMP METHOD IN ANY GIVEN YARD

Conclusion

Conditions as to number of classifications, ratio of cuts to total cars handled, time element and physical conditions are so varied that a definite answer in terms of volume and conditions is not possible. However, the limits within which a detailed study of the advantages of changing from flat to hump switching and methods to be followed in making such a study have been stated and submitted by the committee as Appendix E, page 1014 of Vol. 31—"Formula for determining comparative economies of flat and hump yard switching." This formula has been prepared for publication in the Manual as follows:

NORTH AND SOUTH RAILROAD

FORMULA FOR DETERMINING COMPARATIVE ECONOMIES OF FLAT AND HUMP YARD SWITCHING

ITEM	FLAT YARD		HUMP YARD	
	SOUTH	NORTH	SOUTH	NORTH
(1) Trains - Avg. 24-hr. period (a) Received (b) Dispatched (c) Maximum length cars (d) Maximum number of trains arriving in any two-hour period				
(2) Cars - Avg. 24-hour period (a) Received (b) Dispatched (c) Number Classified (d) Number of Classifications (e) Number of cars for each Classification (f) Average number of cars per cut				
(3) Condition of Service (a) 24, 16 or 8 hour operation (b) Kind of traffic Perishable - percent Other Manifest - " Slow - " (c) Average time of cars from arrival in yard to departure from yard				
(4) Locomotive used - Type, T. E. (a) Yard Switching (b) Transfer (c) Industrial and rip track				
(5) Locomotive Hours (a) Yard Switching (b) Transfer (c) Industrial and rip track				

	No.Men	Cost	No.Men	Cost
(6) Cost of Operation - Avg. 24-hours.				
(a) Wages				
Yardmasters and Assistants				
Yard Clerks				
Yard Enginemen				
Yard Trainmen				
Switch Tenders				
Car Riders				
Car Retarder Operators				
Other Wages				
(b) Locomotive Costs				
Fuel	....		....	
Water	....		....	
Lubricants	....		....	
Other Supplies	....		....	
Enginehouse Expenses	....		....	
Yard Supplies & Expenses	....		....	
Locomotive Repairs	....		....	
Locomotive Interest and Depreciation				
(c) Miscellaneous				
Train Service Employes				
Motor Operation in Yard	....		....	
Bus Service	....		....	
Other Miscl.	....		....	
(d) Signal and Interlocker Operation				
Wages				
Other	....		....	
(e) Power Used for Operation of Lighting, Signals and Retarders				
Electricity	....		....	
Other Power	....		....	
(f) Loss and Damage				
Freight	....		....	
Equipment	....		....	
(7) Maintenance Costs				
(a) Ties	....		....	
(b) Rails	....		....	
(c) Ballast	....		....	
(d) Roadway and Track				
Roadway Maintenance	....		....	
Other Track Mat'l.	....		....	
Tracklaying and Surfacing	....		....	
(e) Bridges and Structures				
Bridges, trestles and Culverts	....		....	
Station and Office Bldgs.	....		....	
Roadway buildings	....		....	
Water Stations	....		....	
Fuel Stations	....		....	
Shops & Engine Houses	....		....	
Power Plant Buildings	....		....	
Power Sub-Station Bldgs.	....		....	
Power Transmission System	....		....	
Power Distributor System	....		....	
Power Lines, Poles and Fixtures	....		....	
Underground conduits	....		....	
(f) Signals and Interlockers	....		....	
(g) Retarder Plant	....		....	
(8) Total Daily Operating Cost	....		....	
(9) Daily Capital Cost	....		....	
(10) GRAND TOTAL DAILY COST	....		....	
(11) GRAND TOTAL COST PER ANNUM	....		....	
(12) AVERAGE COST PER CAR	....		....	

NOTES IN CONNECTION WITH FORMULA FOR DETERMINING COMPARATIVE ECONOMIES OF FLAT AND HUMP YARD SWITCHING

(1) Trains

Data for present yard to be determined from the current reports or special study. In proposed yard reasonable allowance for future development to be made. On these items depend the number and length of receiving tracks necessary. If present capacity of receiving tracks is limiting the length of road trains or causing delay by the necessity of "doubling over," this condition should receive proper consideration in estimating cost of operation of proposed hump yard.

(2) Cars

Data for present yard to be determined from current reports or special study. In proposed yard reasonable allowance to be made for future development. These items determine the number and length of classification tracks necessary.

(3) Condition of Service

The cost of operation of hump switching will depend largely upon the necessity or otherwise of continuous operation over 24 hours. With the provision of receiving and classification tracks of ample capacity and length from 800 to 1,000 or more cars can be handled per 8-hour shift and if conditions of service will permit handling in one or two 8-hour shifts the cost of operation as compared with 24-hour service will be materially reduced. To determine the period of operation necessary, special study of the nature of the traffic must be made, embracing monthly seasonal, and yearly variations and including prospective increase or decrease in volume of business.

(4) Locomotive Used—Type T.E.

The type and tractive effort of locomotives used are required in determining the cost of locomotive service.

(5) Locomotive Hours

(a) Yard Switching.—In yard operation, some of the time of engines nominally engaged in switching is used for transfer or industrial work. Special time study should be made to segregate the time actually engaged in switching. In estimating the locomotive hours required for switching a proposed hump yard, it may be assumed that one engine working on the hump will shove over 800 cars per 8-hour shift. If the requirements are such that a greater number must be handled in any 8-hour period, a second engine will be necessary to bring the cars from the receiving yard. A separate trimming engine is not necessary unless the yard is being worked at peak capacity.

(b) Transfer.—The number of transfer engines employed, present and future, depends on local conditions. Under hump operation it may be possible to reduce the number of transfer engines by reason of elimination of delays waiting for transfer runs to be switched. Local conditions in each yard govern.

(c) Industrial and Rip Track.—Generally the substitution of hump for flat switching will make little or no change in the engine hours employed in industrial and rip track work.

(6) Cost of Operation, per 24 Hours

(a) Wages.—Whether or not it will be possible to reduce the supervisory forces depends entirely upon local conditions. Generally hump yard operations are more restricted in area and the same or closer supervision may be obtained with fewer men. Yard Enginemen—Depends entirely upon the locomotive hours. Yard Trainmen—In flat yard operation an engine is usually operated with a foreman and two helpers; the crew on engines engaged

exclusively in humping can usually be reduced by one helper. Switch Tenders —The number of switch tenders required depends entirely on local conditions. Car Riders or Retarder Operators—This depends upon whether yard is to be operated with car riders or retarders. If the yard is to be operated by car riders, the number necessary per shift depends on the number of cars to be handled and the facilities for return of riders. For estimating the figure of 45 rides per car per man per 8-hour shift may be used. If by Retarder Operators, the number depends on the layout of the yard and the number of retarders provided, and whether or not continuous operation is necessary. For estimating, use three retarder operators per shift or if over 30 classification tracks increase one retarder operator per shift for every additional 10 tracks.

(b) Locomotive Costs.—Interest and depreciation to be figured on class and number of engines used. Repairs—Depend on locomotive hours and cost per yard locomotive mile for the class of locomotive used on the individual road making the study. Fuel, Water, etc.—Depends on the locomotive hours and individual road making the study. Engine House Expenses—This depends upon the number and class of locomotives despatched. There will be no change in the item of yard supplies and expenses.

(c) Miscellaneous.—Bus service and train service employees is intended to cover any change there may be in the location of the yard necessitating provision by the railroad of service from some central point to the location of the yard for the convenience of employees. These costs will be effective in the event of the site of the proposed new yard being at a considerable distance from the present yard where bus and train service is not necessary. Motor operation in yard is intended to cover the cost of operating motors, electric or gasoline, for the purpose of returning hump riders, where same are used, and will depend upon the length of the yard, whether or not continuous service is required and the speed of operation required.

(7) Maintenance Costs

Such items as may be affected are set up in accordance with the official classification, with the exception of the retarder plant. This should include the maintenance of the parts of the retarder plant that are not covered by the foregoing items. Other items of maintenance will not differ per unit as between a flat and hump yard, but provision must be made for additional trackage, additional structures, additions to signal installations, etc.

(9) Daily Capital Costs

This item to include interest, taxes, allowance for depreciation or obsolescence and other fixed charges on the retarder plant, and other additions.

General

The design of a hump yard should, if practicable, be such that it can be flat switched when the volume of business has decreased to a point where hump switching is uneconomical.

Appendix C

(5) SUITABLE UNITS FOR OPERATING AND EQUIPMENT STATISTICS REQUIRED BY THE INTERSTATE COMMERCE COMMISSION TO BE USED ON COST COMPARISONS OF TRANSPORTATION, EQUIPMENT AND ROADWAY MAINTENANCE, WITH NECESSARY ADDITIONS THERETO, COLLABORATING WITH COMMITTEES XI—RECORDS AND ACCOUNTS, XVI—ECONOMICS OF RAILWAY LOCATION, XXII—ECONOMICS OF RAILWAY LABOR

C. H. R. Howe, Chairman, Sub-Committee; H. C. Crowell, W. J. Cunningham, W. W. Judson, E. E. Kimball, L. E. Little, M. E. Mannion, F. H. McGuigan, Jr., O. V. Parsons, H. T. Porter, C. H. Stein, C. C. Williams, John S. Worley.

The general business of railroads is handling freight and passengers, and rules for the separation of charges between these two classes of business have been established by the Interstate Commerce Commission, as an adjunct to its Primary Account Classification.

One of the initial steps necessary in setting up the required statistics is the selection of proper units, in terms of which the relative costs of handling business may be expressed on a comparative basis.

The simplest income statement possible is one which shows the total expense chargeable to the handling of freight and passengers, the total revenue derived from the handling and the resultant profit and loss. It is evident that dividing the total expense of freight or passenger handling by the number of units involved will be the cost per unit for the class of business in question. It is further evident that unit costs so obtained on different railroads, or different divisions of the same railroad are directly comparable.

It is entirely possible to proceed in this wise and establish comparisons account by account, or comparisons of accounts in groups with like groups. But such procedure simply serves as a basis for comparison, and in no manner suffices as explanatory of reasons for variations in costs on different railroads, different divisions, or even for the same territory for different periods.

Costs in terms of basic units are, in fact, statements of results, or effect. The actual comparisons must be obtained through the study of the causes that produce the effect. To make such study it is necessary to segregate the primary accounts into their component sub-accounts applying such further identifying units, or combination of units, peculiar to the item under consideration, as are essential to the analysis.

Valuable as such mathematical data may be any comparison is apt to be misleading unless a thorough understanding is had of all the attendant conditions of operation of maintenance of equipment and of maintenance of way.

It is our opinion that the elements of cost comparison are:

(1) Results in terms of basic units.
(2) Comparison of details in terms of subsidiary units.
(3) Explanatory statement of conditions.

Your Committee finds that the basic units are very definitely established by custom and general use. They are as follows:

Freight Service

The ton and mile are units of standard measure, and it is usual to express the volume of freight business by stating the number of tons carried one mile. The unit being "net ton mile." This can readily be converted into the "revenue ton mile" by eliminating non-revenue freight.

If the total expense is divided by the net ton miles, the resultant figure is the cost per net ton mile. Likewise the revenue divided by the revenue ton miles is the revenue per ton mile.

Notwithstanding the adaptability of the "net ton mile" as a unit on which to base comparisons of cost results, it is evident that consideration must be given to an expression of the volume of business inclusive of the factors that create expenses beyond those incurred in the direct handling of freight tonnage. The "gross ton mile" does so include these factors and is as comprehensive in its application as the "net ton mile," and as a basic unit for comparing efficiency in the conduct of the business it is a more suitable medium.

It will be noted that the net ton mile, the revenue ton mile and the gross ton mile may be applied as units to both rail and water transportation.

Passenger Service

In regard to the selection of basic units, the revenue passenger mile may be applied to water transportation and to actual passenger containing conveyances on rails, but it does not apply to express, mail and similar service hauled in passenger trains. On the other hand, the passenger train car mile can not be applied to marine transportation, so it is necessary to apply different units to rail and marine service accounts.

It will be found, however, that the gross ton mile is applicable to baggage, mail and express cars as well as vessels.

Your Committee submits as suitable Basic Units applicable to all accounts:

Freight Service—Both Rail and Water

Gross Ton Mile
Net Ton Mile
Revenue Ton Mile

Passenger Service

Gross Ton Mile—Both Rail and Water
Passenger Car Mile—Rail
Revenue Passenger Mile—Water

Subsidiary Units

Your Committee is of the opinion that the choice of units necessary for individual account analysis is largely governed by the conditions imposed by the particular problem in question. Such units, and combinations of units, are numerous and of varying importance, and to publish a list showing their application to the individual accounts would serve no useful purpose, as it would be a repetition of subject matter already presented to the Association in the report of this Committee with necessary explanations and submitted in the Proceedings, Vol. 28, pages 514 to 524 inclusive.

The report now presented is submitted as information and it is the recommendation of the Committee that the subject be discontinued.

Appendix D

(6) PROBLEMS OF RAILWAY OPERATION AS AFFECTED BY THE INTRODUCTION OF AIR TRANSPORT LINES, MOTOR TRUCK AND BUS LINES, WITH PARTICULAR REFERENCE TO THE EFFECT OF THE LATTER UPON BRANCH OR FEEDER LINES, COLLABORATING WITH COMMITTEE XIV—YARDS AND TERMINALS AND THE MOTOR TRANSPORT DIVISION, A.R.A.

M. F. Steinberger, Chairman, Sub-Committee; W. N. Deramus, Olive W. Dennis, L. E. Little, O. V. Parsons, Mott Sawyer, S. E. Shoup, C. E. Smith, L. C. Spengler, B. Wheelwright, E. S. Pennebaker and H. Rhoads.

Each year since 1927, this Committee has presented statistics showing the declining passenger revenues of the railroads and the relation of this decrease to the increase in improved highway mileage and in the use of motor coaches, motor trucks and private automobiles.

Inasmuch as a study of the statistics for the year 1930 develops that the same tendencies as were evident in the preceding years continue to exist, the Committee feels it unnecessary to burden its report with a repetition of the printed tabulations heretofore presented.

Suffice it to say that passenger revenues do continue to decrease, more highways continue to be built and more automobile vehicles continue to operate.

But one example will be cited to indicate the seriousness of the situation. One of the Eastern railroads in its compilation of data in the answer to the Questionnaire recently put out by the Interstate Commerce Commission developed that in its territory there were 137 competitive bus companies whose aggregate road mileage was about 28,000 and 405 motor truck companies whose aggregate road mileage was 55,000.

This compared roughly with a rail mileage slightly under 6,000.

The most disturbing feature in both the passenger and freight field has been the increase in distance traveled by motor coach or of freight, both carload and less carload, by motor truck.

Numerous studies made by various roads have indicated that the prime consideration in the use of motor coaches for long distances is the low cost. Long distance motor coach fares average but little over 2.0 cents per passenger mile.

This fact has led to the development of two schools of thought; one, that railroads should continue their development of subsidiary bus lines on the theory that they are better able to furnish a transportation service of this sort, and the other that the railroad companies should establish coach rates comparable with existing bus rates.

A number of experiments in the latter direction have been or are being made, but results as yet have been too indefinite to base any real conclusions upon them.

Improvements in service on the part of railroads is also one of the means for combating the bus competition.

Speeding up trains, individual seat coaches, reclining chair coaches with lunch facilities and other methods have been tried all with more or less success.

It would seem that all these things have a tendency to bring passengers back to the railroad from busses, but it is doubtful if they have any appreciable effect on the users of private automobiles.

An item of prime importance, however, is the growing use of motor trucks. All sorts of commodities, carload as well as less carload are being handled for distances running in some cases to hundreds of miles.

Certain railroads are gradually adopting container car schemes with the thought of handling less carload more expeditiously and at lower cost. It seems to be the general experience that the container as now used can be successfully adopted only for handling freight moved through the medium of a consolidating agency. This because the experience of several roads is that not more than 2 per cent of freight moved in sufficient quantity from a consignor to a consignee to make a single minimum container load.

Other railroads have adopted the expedient of organizing trucking companies which through the medium of over the road trucking of truck-rail movement give storedoor deliveries.

It is storedoor delivery plus no greater costs and expedited service which is giving popularity to the use of the motor truck.

A considerable amount of space would be required to outline the various commodities now being handled by trucks and all other co-related data. We feel, however, that information concerning the inroads being made on railroad traffic has been so widely disseminated that it is not necessary to elaborate upon, and suggest that some discussion may be productive of more interest than the mere presentation of data.

To avoid duplication of efforts being made by the Transport Division, American Railway Association, in the study of this and co-related problems, your Committee recommends that the subject be discontinued.

Appendix E

(9) STUDY AND REPORT ON ECONOMIES RESULTING FROM THE USE OF THE RADIO TELEPHONE FOR LONG FREIGHT TRAINS AND FOR YARD WORK.

J. E. Teal, Chairman, Sub-Committee; J. M. Farrin, E. M. Hastings, C. H. R. Howe, E. E. Kimball, M. F. Mannion, J. F. Pringle and M. F. Steinberger.

This subject was handled last year and a report submitted and published as Appendix H, on page 1027 in Volume 31 of the Proceedings. The concluding paragraph of this report states in part as follows:

> "In general it may be said that the development of radio telephone communication for railroad service is proceeding rapidly, and seems about to emerge from the experimental stage. This will doubtless follow unless the development is restricted by the Federal Radio Commission. Because of the very limited number of radio frequencies available for use in this country and the large demand for frequencies from such services as aviation, police, television and ships at sea, it seems problematical if the Federal Radio Commission will issue permits for general use for retarder yard or train service."

Since the writing of last year's report there have been practically no new installations of radio telephone equipment for use in train or yard service, due

principally to the generally unfavorable attitude of the Federal Radio Commission. In fact, a few of the more important installations which were in service at that time have been discontinued by order of the Commission.

So far there have been no radio frequencies assigned for use by portable radio apparatus in train or yard service, and the Commission will grant only experimental permits for the operation of such apparatus. Any railroad desiring a commercial license for the general use of radio communication in train or yard service must first obtain an experimental permit, install the apparatus and have it inspected and approved by the Commission, after which the railroad must appear before the Commission in public hearing and prove to the Commission's satisfaction that the use of such radio apparatus is in the public interest.

It is evident that there will be no material progress made in the general use of radio communication in railroad operation until it is proved to the Federal Radio Commission that this is in the public interest, or until the development of radio apparatus makes possible the use of even shorter waves than are used in the present short-wave apparatus, which would open up new ranges of frequencies and allow the Commission to assign certain frequencies for the exclusive use of railroad radio communication.

The use of radio communication between shore stations and floating equipment or between different units of floating equipment, such as harbor tugs, ferries, etc., is allowed by the Commission and certain frequencies have been assigned to this service. Any railroad desiring a commercial license for the use of radio communication in such service may do so by first obtaining an experimental permit, installing the apparatus and by having it inspected and approved by the Commission.

The Committee recommends that this report be received as information only, and that the subject be discontinued.

DISCUSSIONS

DISCUSSION ON STANDARDIZATION

(For Report, see pp. 112–118.)

Mr. J. C. Irwin (Boston & Albany):—In making my first report as the Chairman of this Committee I wish to tell you how fully I recognize the honor of succeeding Mr. W. C. Cushing in this important office. When Mr. Cushing expressed a desire to retire from the chairmanship last spring we urged him to continue and assured him that he would have the help of all the members of the Committee to do any work that he felt could be assigned to them. However, he felt that it was time for him to give up the chairmanship and therefore the new Chairman was appointed.

The work of this Committee was started in 1919 and the early stages were ably handled by Mr. E. A. Frink as Chairman. In 1926 Mr. Cushing took up the chairmanship and his very enlightening and excellent reports during the next four years make a fine reference on the subject of standardization and its relation in the A.R.E A. work to the work of other associations which have it in hand.

You will find the report of this Committee in Bulletin 329 on page 112.

In recent years the work of standardization has been so well organized and Mr. Cushing's reports have been so complete that this Committee is enabled to make a very concise report of the present situation.

The Committee feels that its duty appears to be: "To encourage the use of A.R.E.A. Recommended Practices in the railway field, and to promote, as National Standards, such subjects as may be selected for sponsoring by the Board of Direction, from which it receives its instructions." Also, "to maintain contact with standardization bodies and keep the Association informed on important matters developed by such contact."

During the year there have been no subjects which have been referred to the Board of Direction and acted upon by the Board of Direction and handed to this Committee for consideration as National Standards.

The most important development during the past two years; in fact, I think the most important development that has taken place in standardization of the work of this Association is the endorsement and approval of the A.R.E.A. 1929 Manual by the American Railway Association. That is a thing that many of us have hoped for and, so far as a great deal of the material in the Manual is concerned, it seems to be about as far as it should go. If we have the endorsement of the American Railway Association for our Recommended Practices in the railway field, that is sufficient for us to consider that we have the highest authority for the use of these practices in the American Railway Engineering Association.

The members of the Association themselves are the agents through which the use of the Recommended Practices will be extended, and each member, by not only referring to the Manual to aid him in his work, but by using the Recommended Practices so far as he can lay aside any personal differences, will aid in the extension of these practices.

There is a great difference in the material in the Manual as to the importance of its general use. There are some things which affect only the individual railway. They have no influence over the activities of other railways. In those cases, of course, the absolute use of the practices as recom-

mended is not so important. Yet I think a great deal can be done by members in adopting what is in the Manual instead of following some of the old practices which may not conform to it. But when we get into the larger field of the interests between railways, the railways and the manufacturers, and the railways and the general public, it is easy to see that standardization will aid greatly in the saving of time, the saving of money, and in the reducing of friction, especially between railways and industry.

On page 113 we have listed these ideas in regard to the relative importance of the general use of the recommended practices merely as a guide to those who are thinking of standardization in general terms, and to present to their minds the relative importance of the general use, throughout the country, of the recommended practices in matters which have been standardized by national bodies.

In order to facilitate the general adoption of practices in which the interests of the railways are involved with the interests of others, with whom they deal, it is important that the Standing Committees of this Association, to which subjects are assigned in their Outline of Work, secure the cooperation, not only of the representatives of other Divisions or Sections of the American Railway Association, but also of those of other national organizations of public service corporations or of industries as far as practicable, so that when a practice shall have been submitted to and approved by the A.R.E.A., it will have the support of such other bodies concerned in its general use. Without such co-operation, their opposition might defeat the purpose of the establishment of such recommended practice.

Those who use the Manual should call to the attention of Committee Chairmen any real objections they find to the use of any recommended practice so that such objections can be considered in the study of the revision of the Manual and any changes which appear necessary, to make the practice more generally acceptable, can be made by authorized procedure.

On page 114 you will find reference to national standardization. Your Chairman of this Committee is the representative of the American Railway Association, Engineering Division, in the American Standards Association, which meets in what is known as the Standards Council, quarterly, to discuss matters which come up in connection with standardization. The A.R.E.A., through its Board of Direction, can assign to this representative any project that it thinks should be handled by the American Standards Association for national standardization. If such a project is assigned, a Sectional Committee is appointed in the Standards Association, made up of members of various bodies whose interests are concerned. After a long period of meetings, their standards are recommended and they come before the Standards Council for adoption, the Standards Council considering the adequacy of the study and recommendation, the technical work, however, being done by the sectional committees, many of whose members are members of the American Railway Engineering Association.

Page 115 refers to representation. There is a Board of Direction of the American Standards Association, of which Mr. L. A. Downs, President of the Illinois Central System, is the representative of the American Railway Association.

In Canada there is a Canadian Engineering Standards Association. It has a Main Committee, several members of which are members of this Association

and other members who are railway men but who are not members of this Association. The American Standards Association and the Canadian Engineering Standards Association both publish Year Books and Bulletins which they are glad to send to any members of this Association. They will keep you well-informed on the progress of standardization.

Standardization has gone beyond the confines of any one nation, and on page 116 you will see the names of the countries, each of which has national standardizing bodies.

Also, there is an International Standards Association, in which the standards of various countries are considered, but they do not promulgate any international standards as yet. That Association is mainly for the purpose of giving each country the benefit of the work of the other countries.

A conference held in Paris in May, 1931, is referred to on page 116. The Committee presents on page 117 the list of the American standards approved by the American Standards Association in the period from September 1, 1929, to September 1, 1930.

On page 118 it presents a list of the projects which are now being considered by the American Standards Association and in which the railway associations have representatives who are cooperating.

The Committee presents its report as information and invites discussion, and I trust that the other members of this Committee, all of whom are chairmen of standing committees of the Association, will present their views.

The President:—The subject matter of this Committee is very important to the Association and to the country. It is in no sense spectacular but it is no less important. Is there any discussion of the Committee's report?

Mr. R. T. Scholes (Chicago, Burlington & Quincy):—I should like to ask the Chairman whether the question of the metric system has been brought before the Committee.

Chairman J. C. Irwin:—I believe the metric system is under study by a different body. The question of the use of the metric system is not up in the American Standards Association, but there is the American Institute of Weights and Measures, in which Mr. Faucette represents the American Railway Association. We have no report to present on that. In fact the subject is not being considered in the American Standards Association at the present time.

The President:—Is there any further discussion?

Chairman J. C. Irwin:—The Committee recommends that this report be received as information.

The President:—There being none, it is so ordered, and the Committee is relieved with the thanks of the Association (Applause).

DISCUSSION ON STRESSES IN RAILROAD TRACK

(For Report, see pp. 205–206.)

Dr. A. N. Talbot (University of Illinois):—Mr. President: The report of the Committee on Stresses in Railroad Track is found in Bulletin 330, page 205. It is a report of progress of the work done during the last year.

A year ago the Committee made its Fifth Progress Report on the subject of stresses in track, a report which had considerable length in printed pages and in words, and I hope also in ideas. This report summed up several years' work in both laboratory and field.

This Fifth Report presents for the first time a discussion of the way in which a rail-joint acts in track, tells something of its properties, something of the requirements of a satisfactory rail-joint. The Committee felt when discussing the report that a summary at the end was needed, but when the attempt was made to write out a summary it was found that a summary involved very many of the pages that had gone before; a brief review was made up, which was held down in some way to 7 pages. People who have read parts of this report or all of it say that the report requires reading, rereading and restudying, as may be expected in a new and complicated subject. Although not to be considered comprehensive, it is the first study approaching thoroughness on the subject of the rail-joint.

All of the tests on rail-joints reported in the Fifth Progress Report were made by static loading; no tests were made at train speeds. It was felt that certain of the conclusions should not be taken as established until tests were made to find stresses developed with trains in motion. The difficulty had been that no instrument applicable to the rail-joint in track and recording the stresses developed under such conditions was available for use. Within the last year, however, we have made use of an instrument developed by the Westinghouse Electric & Manufacturing Company, called the magnetic strain gage, which does permit of the measurement of these stresses at train speeds at points on the joint bars (with certain limitations), as well as upon the rail, and also the changes in tension in track bolts.

During September and October, 1930, a staff of the Committee participated in tests on the Pennsylvania Railroad near Wilmington, Delaware, with the engineers of the Westinghouse Company in making measurements of the stresses in rail-joints and in rail at low, medium and high speeds. These tests were carried out primarily to determine the action of certain new electric locomotives of the Pennsylvania Railroad. With the electric locomotive, speeds as high as 100 miles an hour were used. With steam locomotives, speeds as high as 90 miles an hour were used.

The results of the tests on rail are being worked up by the Westinghouse Company. I do not know whether the results are in shape for conclusions to be drawn. The general impression is that so far as average stresses in base of rail under all the wheels at a given instant are concerned, the effect of increase in speed was not very great, and that the principal source of maximum stress is the transfer of weight from one wheel to another of an axle or from one wheel to another in the length of the locomotive or car. This transfer of load

from wheel to wheel, of course, is one source of increase in stress. It does not consider the increase of stress under all the wheels as an effect of speed on the average of all the stresses for a large number of runs due to other causes. Of course, I am speaking now of stresses that are due to balanced loading and not to imperfect counterbalancing.

On the joint bars (angle bars and other forms of joint bars) the instruments are placed at such points as may be practicable, both at the top of the bar and at the sides, both at mid-section and at different distances along the length of the bar. The measurement of stress in the joint bars was made at speeds up to 70 miles an hour, and in a few instances at 90 miles an hour. Time was an important element in the conduct of the tests, and no need was felt for many tests at speeds higher than 70 miles an hour.

The test results are being worked up. The work has not been carried sufficiently far to enable definite conclusions to be drawn, but in a general way it may be said that the action found in the track under speeds, even at these higher speeds, is very similar to that found in static loading in track and in static loading in the laboratory reported in the Fifth Progress Report. The stresses in joint bars have only a moderate amount of increase with speed, not more than had been expected. There are not enough data, not enough runs, to state a conclusion finally, however.

In regard to bolt tension, it will be remembered that in the Fifth Progress Report of last year the Committee cautiously made a statement concerning the results of the tests made under static loading, that only a moderate change in the amount of tension in a bolt of a rail-joint is to be found upon its being loaded and unloaded and loaded again, as between the unloaded condition and the loaded condition, and that more generally the change is a decrease in tension of the bolt but that in some bolts small increase occurs. The amounts of these changes were of the nature of 1500 pounds tension change, increase or decrease, or even 2,000 pounds, but generally smaller than those values. These conclusions were not in accord with the results given in Exhibit A attached to the report of the Committee on Rail for the same year, and it was considered important to determine whether the large increases there reported occur. All the tests at train speeds, recently made by the Committee, even at the speed of 70 miles an hour, give results similar to those obtained by static loading reported in the Fifth Progress Report and have about the same quantitative changes in tension—changes of 500 pounds, 1,000 pounds, 2,000 pounds. And generally the changes were decreases. So it is to be expected that the change in tension in a bolt upon loading is not great and its effect relates to the twisting and lateral bending of the joint bar and its deflection rather than to slipping with regard to its bearing at the fishing surfaces. The conclusion, it seems to me, is important, since it defines the purpose of bolt tension. One purpose of bolt tension in an angle bar is to keep the bar restrained in some way rather than to keep it from slipping and wearing. The bolt tension needed does have an effect, of course, upon the size of the bolt to be used, especially as to whether the adoption of larger rails require the use of larger bolts.

In the laboratory, tests have been made with various types of joints, making accurate measurements to find the amount of vertical movement between rail and bar, the vertical bending of the bar, the lateral bending of the bar at top and bottom, in an effort to see what differences there may be with different

types of joints. We are also working to find the effect of length of the bar when a load is moved over the length of the bar.

It had been expected last season that more extended tests would be conducted at other points on railroads, but in this, as in other things, business conditions made postponement necessary. It is now planned to carry on tests in two or more places the coming season, in addition to the work to be done in the laboratory. A considerable amount of work on rail-joints remains to be done to cover points at issue. It is hoped that further tests will give information of value.

The President:—I am sure that Dr. Talbot will be glad indeed to answer any questions which interested members might wish to put to him, or welcome any discussion of this subject.

Mr. Edwin F. Wendt (Consulting Engineer):—I desire to make a few general remarks which are applicable not only to the work of this Committee but to the work of all of the Committees of this Association. We heard the report of the Committee on Standardization and the Committee on Stresses in Track and their reports suggest remarks which I am about to make.

The Transportation Act of 1920 provides for the consolidation and unification of railroads into a limited number of compact systems. Recently the principles underlying that act have been questioned.

While our Association has nothing to do with the political phases of any movement, we are interested in this question as to whether the unification of railroads into a limited number of systems such as twenty is justified on the grounds of economy and efficiency. It seems to me that the work of our Association is a conclusive answer to any question that may arise as to the wisdom of the law which provides that consolidations and unifications may be made under the approval of the federal regulatory body. So long as we have a large number of railroad properties under independent operation we cannot hope for the economies which will come following the unification which is provided for in the Transportation Act of 1920.

I make these remarks because I think this is a peculiarly appropriate time for engineers, not only as engineers but as citizens of this country, to study this question. The economies which have been pointed out heretofore by our various Committees, are one of the many answers which may be made to any criticism that is offered upon the Transportation Act.

The President:—Is there any further discussion? If not, the report will be received and the Committee relieved with the hearty thanks of the Association (Applause).

DISCUSSION ON UNIFORM GENERAL CONTRACT FORMS

(For Report, see pp. 107–111.)

Mr. J. C. Irwin (Boston & Albany):—The report of this Committee is very short. As I am retiring as Chairman but not from membership of this Committee, I hope you will pardon me if I take one minute to testify to the splendid service of one of our senior members. I refer to Mr. C. A. Wilson, who is a Charter Member of this Association, and is No. 9 on its list of members. For 22 years he and I have worked together on this Committee and I wish to acknowledge his sound judgment, his absolute fairness and his earnest work for this Committee and for the Association. Another of the older members is Professor C. Frank Allen, Massachusetts Institute of Technology, whose skilled assistance we have had for 19 years.

This is a tribute but not an obituary, because both of these men are still active members of the Committee.

The report of this Committee will be found in Bulletin 329, page 107, with the outline of work and then the action recommended.

The details of the report will be presented by the respective Sub-Committee Chairmen. On the first Sub-Committee, Mr. Charles Silliman, Chairman, is absent, and Mr. F. H. Fechtig will present the report.

(Vice-President J. V. Neubert assumed the chair.)

Mr. F. H. Fechtig (Atlantic Coast Line):—Sub-Committee No. 1 has taken up Cost-Plus Methods in Construction Contracts. I do not suppose that you will care for me to read it all, as it is fully shown on page 108.

"The Committee presents such a modification in the provision for a Cost-Plus a Stated Sum with Adjustments for Varying Conditions," and we thought it well to call your attention to it.

"The Committee points out that the use of the term 'Fixed Fee' where changes in the fee are provided for in the contract is an incorrect use of the term and is apt to be misleading."

The balance of this report is shown on pages 108 and 109. It is so full that it would take quite some time to read it and I presume you do not care to have it read. The conclusions are:

"Where limitations in the strictly Cost-Plus Percentage basis are desirable, the Committee recommends as best practice that the agreements take the form of:

"(a) Cost-Plus-a-Fixed-Fee.

"(b) Cost-Plus-a-Stated-Sum with Adjustments for Varying Conditions.

"The Cost-Plus-Fixed-Fee form should not be used where there is a likelihood of there being any change in the amount or conditions of the work involved.

"Instead of rewriting the adopted form of Cost-Plus Percentage Construction Contract as printed in A.R.E.A. Manual for 1929, provision can be made for desired limitations by the attachment of an appendix to the standard form. It submits as suggestions for such the following: Appendix I—Cost-Plus-Fixed Fee, and Appendix II—Cost-Plus-a-Stated-Sum with Adjustments for Varying Conditions.

These two appendices are shown on pp. 109 and 110.

Chairman J. C. Irwin:—You can look it over; probably those who wish to discuss it have already done so. After permitting time for scanning, we shall present our recommendations.

Vice-President J. V. Neubert:—Proceed.

Chairman J. C. Irwin:—I move that Appendix I and Appendix II, as presented on pages 108, 109 and 110, be accepted by the Association and adopted for printing in the Manual.

Vice-President J. V. Neubert:—Are there any questions or remarks? All in favor say "Aye." Contrary? It is carried. Proceed, Mr. Irwin.

Chairman J. C. Irwin:—The next report will be that of Sub-Committee No. 2, to be presented by Mr. F. L. Nicholson, Chairman of the Sub-Committee.

There is another reference, if I may revert to the previous report, in regard to the Cost-Plus modifications in Percentage Construction Contract. Just after coming into the room this morning a discussion was presented in writing, coming from Mr. G. S. Fanning, Chief Engineer of the Erie Railroad. He suggested that instead of using the term "basic," which we have used and which by the way is used in the Pennsylvania Railroad standard form, we should use the term "basic estimated cost." I really think that on account of the way it is used the word "estimated" is assumed to be there, because it refers to the estimate.

Another suggestion was that we call this a "Contract for Cost-Plus-a-Varying-Fee." These criticisms have not come in time to be considered in the Sub-Committee or the Committee, although the matter has been up for over two years. You can readily see that it is impossible for us to pass on or suggest any changes of this kind at this time, where after two years of study we are coming up and making a recommendation. Therefore, I should like to record the interest of Mr. Fanning in the subject, but I am not in a position to ask for any changes in the recommendations for adoption in the Manual. That, of course, may be considered in connection with revision of the Manual for future years.

There is one subject that I should mention, that is, one of the assignments for Sub-Committee No. 1 which I overlooked. That was the study of Special Forms of Contracts for Maintenance-of-Way Work.

A very extensive questionnaire was sent out and answers received in regard to the value of a special form of contract for maintenance-of-way work. There was practically no interest shown in it. All replies indicated that the standard form of contract, the Recommended Practice form for Construction Contract would serve, and the recommendation of this Committee in connection with this subject is that no special form of contract for maintenance-of-way work is necessary and that none be recommended for publication in the Manual.

Before departing from this subject, I move that this be accepted as information and that the subject be discontinued.

Vice-President J. V. Neubert:—If there is no question on that matter, the Committee on Outline of Work will handle that subject. Does Mr. Fanning want to make any remarks?

Mr. G. S. Fanning (Erie):—No remarks.

Mr. F. L. Nicholson (Norfolk Southern):—This subject is: "Form of Agreement for the Purchase of Electrical Energy in Large Volume (such as Required for Traction Purposes, collaborating with Committee XVIII—Electricity."

The subject assigned to the Committee we feel is of great importance and we are proceeding slowly. The Committee has prepared a tentative draft of the form but it is not at the present time in shape for presenting to the Association and our recommendation is that the subject be continued.

Chairman J. C. Irwin:—The next is the report of Sub-Committee 3, as shown in Appendix C, page 111, to be presented by Mr. W. G. Nusz, Chairman of the Sub-Committee.

Mr. W. G. Nusz (Illinois Central):—The Committee assignment was to prepare a Form of Agreement for the Organization and Operation of a Joint Passenger Terminal Project, collaborating with Committee XIV—Yards and Terminals.

Your Committee reported progress at the 1930 convention and submitted at that time a preliminary draft of the Form of Agreement for the Organization and Operation of a Joint Passenger Terminal Project, for criticisms and suggestion.

A number of very helpful suggestions have been received, during the past year, from both the members of the Association and others.

Your Committee feels that the importance of the assignment is such that every effort should be made to obtain as many suggestions as possible before a final form is submitted to the Association. At the present stage of development it is not considered necessary to reprint the form at this time, and your Committee again submits the agreement, as printed in Bulletin 320, for information and discussion, and recommends the subject be continued.

Vice-President J. V. Neubert:—If there is no question on that we will proceed with the report.

Chairman J. C. Irwin:—You can recognize the importance of this assignment and also the length of study necessary in order to get it right. We have collected information from all the railways in the country interested in joint terminals. This Sub-Committee has discussed them and for the past two years a draft, consisting of fifty pages of typewritten matter, has been under study and revision. This Committee wishes to continue this study during this year at least and we hope that it will be in shape for presenting at the next annual convention. Any of you who have suggestions in regard to this form, the basis of which was printed in last year's Proceedings, will help the Committee by sending in your recommendations.

That completes the report of this Committee.

Vice-President J. V. Neubert:—Has Mr. Ripley, of the New Haven, any questions to ask or comments to make in regard to this report?

Mr. H. L. Ripley (New York, New Haven & Hartford):—The Yards and Terminals Committee have been in close touch with this Committee throughout the proceedings. They have made their recommendations. The original outline or suggestion for this work came from the Yards and Terminals Committee, not in the form of a contract form, but more nearly perhaps as a declaration of principles. The two committees have worked in close cooperation and I think in close harmony. I expect that when this Committee reaches

its final draft of a form for the general contract it will follow that the Yards and Terminal Committee can accept it.

Chairman J. C. Irwin:—I will say in reply that this is practically the work of the two committees. As Mr. Ripley says, it was originated by the Yards and Terminals Committee by submitting the elements of a suitable agreement. Every move that has been made by Committee XX—Uniform General Contract Forms, has been referred to the Committee on Yards and Terminals, and their views have been brought together before any action was taken.

Vice-President J. V. Neubert:—Are there any other questions. If not, the Committee is excused with the thanks of the Association (Applause).

Mr. G. S. Fanning (Erie) by letter:—On the form of contract for Cost-Plus-a-Stated-Sum with Adjustments for Varying Conditions, there has been some comment from members of our staff on the term "Basic Cost," as it is not really a cost but an estimate. It is suggested that this estimate be termed the "Basic Estimated Cost." The final revision of this "Basic Estimated Cost" is referred to under (d) of the proposed Section 42 as the "revised Basic Cost," in the second line of the first paragraph, and as the "final Basic Cost" in the second line of the second paragraph.

The purpose of this form of contract, which I prefer to call a "Cost Plus a Varying Fee" contract rather than the long title used by the Committee, is to provide an incentive for the contractor to keep down the cost of the work. It is, in my opinion, the best form of Cost-Plus contract that there is. Cost-Plus-Percentage provides an incentive to run the cost up and Cost-Plus-a-Fixed-Fee provides no incentive for anything. Our experience with this form of contract, which has been somewhat extensive, has indicated the necessity to separate the plant rental from other costs. Plant rental is a wonderful way for a contractor to make a profit, if things are not going so well in other directions. Our practice has been to set the plant rental up for the whole job as a fixed amount to be paid the contractor, which does not vary, except where conditions beyond the control of the contractor require the retention of plant on the job for a longer period than was figured on in establishing the fixed amount. The estimated plant rental is kept separate from the "Basic Estimated Cost" and the actual plant rental costs are kept separate from the actual cost and are not used in the computation of the fee.

While we have had considerable experience with this form of contract, none of it leads us to the thought that it is a particularly desirable form. The contractor can always find many reasons why he should be paid the full basic fee when the costs exceed the "Basic Estimated Cost," but I have never found any of them ready to argue that the fee should be restricted to the "Basic Fee" when, through some happy circumstance for which they were in no way responsible, their costs were less than the "Basic Estimated Cost." Furthermore, I have never found that this form of contract can be made to work on a competitive bid basis.

In spite of its faults, for most of which the contractors are responsible and as a result of which they are the chief sufferers, I have yet to see any method of letting contracts which is as satisfactory as the Lump-Sum or Unit-Price contract, awarded after competitive bids from selected, qualified contractors.

DISCUSSION ON CLEARANCES

(For Report, see pp. 95–98).

(Vice-President J. V. Neubert in the chair.)

Mr. A. R. Wilson (Pennsylvania):—This Committee report is found in Bulletin 329, page 95.

Your Committee respectfully submits the following as its report: Clearances diagram for Bridges and Tunnels, Fig. 1. Clearance diagram for Buildings and Sheds, Fig. 2. Clearance diagram for Warehouse and Enginehouse Doors, Fig. 3. Clearance diagram for Platforms, Fig. 4. (a) The clearances on straight track shall not be less than those shown. (b) On curved track the clearances shall be increased to allow for the overhang and the tilting of a car 80 ft. long, 60 ft. between centers of trucks and 14 ft. high. (c) The superelevation of the outer rail being in accordance with the recommended practice of the American Railway Engineering Association. (d) The distance from top of rail to top of ties shall be taken as 8 inches. (e) Legal requirements to govern when in excess of dimensions shown. The information contained in this report pertaining to Buildings, etc., as shown in Fig. 2, 3 and 4 was developed by Committee VI—Buildings.

As to assignment covering clearances as affected by half-through intertrack girders and other structures; representatives of this Committee and the Car Construction Committee, A.R.A., have issued a questionnaire covering the outline of a proposed standard box car, information covering which when received will enable your Committee to more intelligently prepare the diagram as covered by this assignment. As the replies to the questionnaire are incomplete, this subject will not be reported at this time.

Since the publication of this report, the Committee has received several criticisms affecting the clearance diagram for Platforms, Fig. 4. As the Buildings Committee have not had an opportunity to develop this subject to completion and make final report at this time, it is our desire to withdraw Fig. 4 and any reference to it in our report.

There have been handed to us this morning comments by Mr. H. F. King, Special Engineer of the Erie Railroad; Mr. E. T. Johnston, Special Engineer, Mr. Benjamin Elkind, Chief Draftsman, of the same company. These comments seem to cover in part this Fig 4. However, I shall read the comments by Mr. H. F. King.

"I have gone over the report of Special Committee on Clearances and believe their diagrams are satisfactory, with the exception of the high platform serving refrigerator cars. This platform is shown as 3′8″ above top of rail. We experienced trouble at Pier 9 and also at other points, due to the fact that not all doors on refrigerator cars would clear this height of platform, so we reduced the height to 3′6″, and are using that height for all platforms that serve refrigerator cars.

"In this matter of clearances, it seems to me that some agitation should be started, possibly by the Association, to have the public utility commission adopt the A.R.E.A. Standard. I have in mind particularly the Utility Commission of Ohio, where the present regulations covering clearances is working a hardship on all the railroads in the state. I do not know if the Association would back a thing of this kind, but it might be well to determine what stand it would take."

The comments by Mr. E. T. Johnston, Special Engineer, are as follows:

"These clearances, I believe, are proper, with the exception of the platform height for refrigerator cars, shown in Fig. 4, page 98, Bulletin 329.

"It does not seem proper to show this dimension (3'-8") on a clearance diagram as it obviously has no effect on clearances, the maximum height for a platform 5'-9" from center line of track being shown on the same diagram as 4'. In the case of an inspection platform it appears to be too high (3'3" was used at Buffalo where some subsidence of the service tracks was expected). I would therefore recommend that this dimension be eliminated from the diagram as irrelevant."

The comments by Mr. Benjamin Elkind are all in reference to the Committee's comments as to the height of platform affecting refrigerator cars. The following comments also refer to the height of platform affecting refrigerator cars and are submitted by Mr. C. D. Horton, Assistant Engineer in Charge of Clearances:

"Paragraph (2), page 95, Bulletin Vol. 32, 329, states that allowance be made on curved track for a car 80 feet long, 60 feet between centers of trucks. This, in my estimation, is not enough. It is not out of the ordinary to handle loads longer than this. Allowance should be made for loads placed on three 40-ft. flat cars, or a load 120 ft. long. Such a load properly bolstered would be approximately 85 ft. between bolsters or bearings. Therefore, my belief is that paragraph should read as follows:

"'(2) On curved track the clearance shall be increased to allow for the overhang and the tilting of a car or load 120 ft. long, 85 ft. between centers of trucks or bearings of load and 18 ft. 6 in. high.'

"Paragraph (d). I assume the 8 inches between the top of rail and top of tie is to offset the gradual increasing height of rail and thickness of tie plates. This, I believe, has an advantage in overhead clearances, but in platform heights its effect is the opposite. The distance between these two planes should not be mentioned, as the controlling distance is only from top of rail to top of platform. It will be several years before rail 8 inches high will be used in sidetrack construction. The use of tie plates on tracks where refrigerator cars are spotted is, in my opinion, poor practice, due to deterioration of the plates by brine drippings. Without plates none of the eight inches referred to would be taken up.

"My idea would be to place platform the proper distance above top of rail regardless of type of rail to be used, making no mention of distance between top of tie and top of rail. The adherence to a specified distance would necessitate shimming of rails. The gradual increase of heavier rails for sidetracks would be offset by the gradual decrease of the floor heights of cars which would tend to keep the distance between top of rail and platform the proper height without disturbing the elevation of ties.

"Regarding Fig. 1, page 96. The clearance line of top angle is shown as beginning 16 ft. above top of rail. If this began at 18 ft. above, an additional 12 inches in width is gained at a 19 ft. height. This would necessitate 45 degrees bracing on bridges in place of the 33 degrees as suggested in Fig. 1. The cost of the increase in the weight of upright members in bridges would, I believe, be offset by the advantage of greater clearances.

"The additional clearance gained by this would permit much larger load in case of increased track centers, which is a future probability.

"('Mr. Horton may be looking too far into the future. On the other hand, I do not think that the proposed standard looks far enough. Our standard on the Erie for this carries the 8 ft. side clearance to an elevation 17 ft. above the top of rail.'—G. S. Fanning, Chief Engineer.)"

The action of the Committee would then read: "That the clearance diagrams, Fig. 1, 2 and 3, and paragraphs a, b, c, d and e be approved and revisions substituted for the present recommendation in the Manual."

I move adoption of the recommendation.

Mr. Edwin F. Wendt (Consulting Engineer):—I desire to make some remarks on a subject which is indirectly related to the work of this Committee.

The Railway Age and the Engineering News-Record, among other technical journals, have recently called attention to the great diversity in the clearance requirements of the Federal Government in connection with the construction of bridges over navigable streams and harbors.

This subject was recently brought to the attention of the American Engineering Council by Mr. C. E. Grunsky of San Francisco, Past-President of the American Society of Civil Engineers, and at the present time President of the American Engineering Council.

While this subject is not directly under consideration by the A.R.E.A. Committee, I think it well to call attention to the fact that the Engineering Council has arranged for a comprehensive and general survey to be made.

We all know that the requirement as to the height of a bridge over a navigable stream or harbor has a direct relation to the cost of the project and the cost of operation of the railroad. It is perfectly astounding as to the different requirements that have been prescribed as to the clearances over the various streams of our country which come within the regulatory power of the Government. Any study of projects that not only have been carried out but have been proposed for the improvement of transportation facilities in the vicinity of our great cities such as New York, San Francisco, New Orleans, and other places is sufficient warrant for the initiation of a general survey and study which will place within the literature of our profession the facts which are necessary for the formulation of future recommendations.

One more word. The American Engineering Council represents 58,000 Engineers in our country. It does not conduct any studies that interfere in the least with the work of any national engineering association. Its function is to represent the entire engineering profession in any and all matters which affect the welfare of Engineers, and the study which I have just referred to will be conducted largely by member organizations of the Engineering Council.

Vice-President J. V. Neubert:—Is there anyone else that wishes to make any remarks or discussion?

Mr. F. R. Judd (Illinois Central):—It occurs to me that paragraph (b) should be modified so as to provide for structures affected by freight cars only. The car mentioned is 60 ft. wheelbase, 80 ft. long. The wheelbase is longer than the average freight car. For structures that are affected by freight cars only, the paragraph should be modified to provide for a freight car of proper length and proper center.

Chairman A. R. Wilson:—I think it undesirable to limit these clearances, as it may be necessary to cut out and sidetrack a passenger car, which would not be possible if clearances were restricted to freight cars only.

Mr. F. R. Judd:—I believe we should provide clearances for structures designed to accommodate freight cars only, especially where the ground is expensive and track connections of that kind may be such as to interfere with the operation of passengar cars.

Mr. G. S. Fanning (Erie):—I think the clearances where there are freight cars operated are apt to be greater than for passenger equipment, particularly triple loads. We had a good many shipments last year of 120 ft. piles from the West Coast loaded on three flat cars, which gave abouf the worst condition

you could get anywhere. In fact, we had some trouble with them on 13 ft. centers.

Mr. H. L. Ripley (New York, New Haven & Hartford):—I wonder if Mr. Judd has taken into consideration that very serious consideration is being given to 65 ft. freight cars with a wheelbase approaching the 60 ft. limit.

Mr. F. R. Judd:—That is what I am questioning now. I was wondering if there were any such cars under consideration because they haven't come to my attention.

Mr. H. E. Hale (Presidents' Conference Committee):—I had the opportunity of discussing with the Chairman, Mr. Wilson, some marked changes in equipment, particularly the Northern Pacific engine which is the largest one that has come to my attention, 11 ft. 8 in. wide and 125 ft. long. There are remarkable changes going on, and I imagine it is going to be hard for our committees to keep in touch with them.

Mr. Louis Yager (Northern Pacific):—I should like to inquire of the Committee whether all of the questions of joint interest with the A.R.A. Mechanical Division have been ironed out in the recommendations that are now presented. I notice here they speak of the joint questionnaire on the part of the Car Construction Committee. Is it correct that that represents only the questions at issue with respect to half-through intertrack girders and other structures, and that the other matters have been ironed out, and there is agreement in the clearance diagrams that are presented for approval?

Chairman A. R. Wilson:—The question of standard box car has not been concluded with the Mechanical Division. Is that your question?

Mr. Louis Yager:—Then the interest of that Committee is satisfied in these clearance diagrams?

Chairman A. R. Wilson:—As far as I understand, yes. The outline of the box car would be well within this diagram.

Mr. V. R. Walling (Chicago & Western Indiana):—Do I understand that the recommendation of the Chairman of this Committee is to include paragraph (d), referring to distance from top of rail to top of ties to be taken as 8 inches. I presume the Committee has good reason why they think it is desirable to include that. As far as I am concerned, I do not see the necessity of it. It seems to me it might be somewhat confusing. I should think it might be well to withdraw that unless there is good argument for including it.

Chairman A. R. Wilson:—It is particularly desirable to know what to use for the height of the rail. The Committee felt 8 inches would be a figure we could use without getting into difficulty. It is particularly true with respect to Fig. 1.

Mr. C. W. Baldridge (Santa Fe):—In the Committee meeting in which this 8 inch measurement, which has been challenged, was considered, we investigated the Manual. I think if you will look in the Manual you will find that the Committee on Iron and Steel Structures have already specified that the height of rail when not otherwise indicated would be taken as 8 inches, and that figure is already in the Manual.

Vice-President J. V. Neubert:—Is there any other discussion? Are you ready for the question? That is, that Diagrams 1, 2 and 3, and paragraphs a, b, c, d, and e be adopted and printed in the Manual.

(The motion was put to a vote and carried.)

Chairman A. R. Wilson:—This completes our report.

Vice-President J. V. Neubert:—Are there any other questions to be asked this Committee? This Committee in personnel is small, but in my estimation in stature they are strong. They have some very interesting problems, especially with the Mechanical Division of the A.R.A. (I happen to be on this Committee), particularly as regards clearances of the large-size box car that they have under consideration. I think one of the greatest factors we have to contend with to-day is the clearance of our various properties. That is particularly true of the Eastern territories where clearances are more confined than in the Western territories.

If there are no more remarks, the Committee is excused with the thanks of the Association (Applause).

DISCUSSION ON ELECTRICITY

(For Report, see pp. 321–323.)

(Vice-President J. V. Neubert in the chair.)

Mr. D. J. Brumley (Illinois Central):—Unfortunately, the Chairman and Vice-Chairman of this Committee are not present this morning. The Committee has thirty-one members, but unfortunately the representation is reduced to Messrs. Vandersluis, Winship and myself.

The Electricity Committee's report appears in Bulletin 332 at page 321. The work of the Committee is briefly summarized under the heading of seventeen Sub-Committees. It might be well for us to take the time to review very briefly the activities of each of the Sub-Committees contained in this Committee report.

First is Revision of the Manual. The Committee has completed specifications for black varnished cloth tape, straight and bias cut, both of which were approved for publication in the Manual of the Electrical Section, and also recommended practice for the protection of tracks used in the loading or unloading of inflammable liquids from danger of fire caused by electric sparks. This was approved by the Electrical Section and ordered published in the Section Manual.

Second, the subject of inductive coordination is an exceedingly important one as it involves the interests of railroads and power supply. No conclusion is reached on this Committee's work until further cooperation is had with other organizations interested in the subject.

The third Committee's report is that on power supply. This Committee is divided into three sections: giving consideration, first, to steam power available for traction and general power purposes; second, water power available for traction and general power purposes; third, internal combustion engine power supply.

I might say in this connection that the details of the Electrical Section report are published in Bulletin 328 of August, 1930. Those of you who are interested in more of the details than appear under the Electricity Committee's report of the A.R.E.A. should refer to Bulletin 328.

The chief objects of the Power Supply Committee are, first, to study and classify electric power requirements for the railroads; second, to acquaint the railroads with the major sources of power supply; third, to study methods of production and distribution for utilization on railroads and other industries.

The Power Supply Sub-Committee made a rather extended report, and I should like to take time enough to direct your attention to a few essential features. Power supply information was obtained from a number of sources. The departments in Washington furnished a great deal. Information of a similar character was obtained from authorities in the Dominion of Canada, and also from the National Electric Light Association. As an indication of the importance of the power industry and railroads as well, the National Electric Light Association reports information of this sort: Total horsepower per establishment in 1904, 62; in 1927, 203, an increase of 61 per cent. Total horsepower per wage earner in 1904, 2.5, and in 1927, 4.7, an increase of 45 per cent. They have made other comparisons which indicate the importance that power has taken in all forms of industry.

The Power Supply Committee's report contains five exhibits. Exhibit A shows the capacity of generators installed in public utility power plants in the United States, and indicates that in 1927 the total output was 126,789,000,000 kilowatt hours, and for the United States and Dominion of Canada a total of 128,233,402,000 kilowatt hours.

Exhibit B is a graph which shows the rapid growth of installing hydro-electric and steam generating plants in the United States. In 1921 the total energy generation was 41,000,000,000 kilowatt hours, and in 1928 the total generated was 128,000,000,000 kilowatt hours.

Exhibit C is a graph which shows the relationship of the different forms of primary power. It appears that in 1929 water power consisted of 13,000,000 horsepower; internal combustion engine power, 3,000,000 horsepower, and steam power 50,000,000 horsepower. It is apparent from this that steam generation is very much more important than either internal combustion engine or water power.

Another very important and interesting development was the greater efficiency in the more modern and newer installed generating plants. This is evidenced by the fuel consumption per kilowatt hour. In 1902 the average for all stations was 6.2 pounds of coal per kilowatt hour. In 1919 the coal consumption had been reduced to 3.2 pounds per kilowatt hour. In 1929 the coal consumption per kilowatt hour was 1.7 pounds of coal.

Another exhibit was furnished by this Committee which shows the use of electrical energy in the operation of railroads. I think it would be well for you gentlemen to refer to Bulletin 328 and look that table over sometime at your leisure.

There are other points in connection with the Power Supply Committee to which I should probably draw your attention. That is the general improvement in the design of central station plants, as you all very well know. Not only has the size of the units of these plants increased very materially—now with single units of 160,000 kilowatt capacity—but there is now in contemplation the installation of plants with single units of 400,000 kilowatt capacity.

Furthermore, steam pressures which not many years ago were considered high at about 300 pounds have been supplanted with steam generating plants with steam pressures of 1200 to 1400 pounds, and very high temperatures too, 750 to 800 degrees Fahr. Stations are now under design with steam pressures ranging from 2500 to 3200 pounds, so the end is not reached. Furthermore, as

improvement of the design advances the railroad companies or users of power will be able to purchase electrical energy at a lower cost per kilowatt hour.

One other important matter discussed by the Power Supply Committee was the rating of rivers. This was an assignment given the Electricity Committee about five years ago to cooperate with other technical organizations in developing a standard method of rating water power of rivers. You will find this in Bulletin 328.

The Electrolysis Committee has continued its study of electrolysis and the measures taken to mitigate electrolysis in connection with the Cleveland Union Terminal and Delaware, Lackawanna & Western electrifications.

The Committee on Cooperation in Miscellaneous Regulations has continued its work in conjunction with other organizations, such as the National Electric Light Association, and other similar organizations.

The Committee has also made a study of overhead transmission line and catenary construction. Tentative specifications and work have been prepared on copper trolley wire and bronze trolley wire.

One Committee of the Electrical Section is co-operating with Committee XVI—Economics of Railway Location as affected by electrical operation. This report will be presented to the Association during this session.

Another Committee has prepared a report on the standardization of insulating tape, and another on the standardization of insulators.

A Committee has prepared a report on protection of oil sidings from danger due to stray currents. Mr. L. C. Winship, Chairman of that Committee, is present and he will present the report.

Mr. L. C. Winship (Boston & Maine):—The rules covering the protection of oil sidings from danger due to stray currents which are now recommended practice were adopted by the American Railway Association in 1924, and deal chiefly with protection against stray electric currents. Recent studies and developments in the field of protection from danger due to electrical ignition of inflammable liquids have indicated the need of a simple method, universally applied, for protection against danger from what is now known as static electricity. The revision of the current rules offered for approval as recommended practice provides for such protection.

This revision also provides for certain minor changes in the rules which appear desirable. These changes are a re-wording of the designation of the Committee; the omission of the 30-degree Fahr. flash point in the description of inflammable liquids; the omission of reference to the temporary flexible connection between the car and pipe system and the omission of reference to the non-metallic hose.

These are the main features of the change in the existing rules. The first section of the proposed rules deals with the universal protection against static electricity. It is worthy of note that this Sub-Committee has worked with a similar Committee of the American Petroleum Institute and that the rules proposed show an almost complete agreement between the two committees.

It may also be of interest that the further work of this Committee will have to do with the preparation of rules for protection in the handling of inflammable liquids as used for rail coaches and buses, a subject which has not received much attention on the part of the railroads but has received very marked attention on the part of the American Petroleum Institute.

Past-President D. J. Brumley:—Committee No. 12 prepared specifications for track and third-rail bonds.

Committee No. 13 is making a study of illumination, one of them being the floodlighting of railroad yards. It is likely that in the near future this Committee will be in position to submit a detailed report.

Committee No. 14 is considering the design of indoor and outdoor substations. The report made last year covers substation insulation, working clearances and relay protection.

Committee No. 15 is making a study of high tension cables. It is probable that very high voltage cables will be developed in the near future which will permit of transmission lines through cities in underground conduits rather than wires carried on pole lines over the streets in the air.

Committee 16 is making a study of the application of corrosion-resisting materials to railroad electrical construction. This Committee has begun a series of tests, none of which have been brought to a conclusion, but I am quite sure that these tests will show not only information of great interest to the electrical industry but also to the railroad industry in general.

The Electrical Section has a committee on the form for power contract for large blocks of power. This in effect is doing work in cooperation with Committee XX—Uniform General Contract Forms.

Very briefly that is the report of the Electricity Committee, and is submitted as information.

Mr. Edwin F. Wendt (Consulting Engineer):—I desire to call the attention of the members to a most statesmanlike address recently made by General Atterbury, President of the Pennsylvania Railroad System, in which he outlined the present and prospective growth of all forms of transportation. He called particular attention to the coordination of transportation by rail, by highway and buses and in the air by airships. Among other things he mentioned the development of the application of electricity to traction and transportation, and, as I understand it, the plan now is to electrify all parts of the Pennsylvania Railroad System east of the Susquehanna Valley and as far south as the Potomac Yards of the Richmond, Fredericksburg & Potomac Railroad.

It occurred to me, after reading that address, which, by the way, I call a statesmanlike speech because it presents a hopeful view as to the future development of transportation of all forms, that this subject of electricity is of such great importance that it behooves all Civil Engineers in charge of construction and maintenance to keep abreast of the times and to anticipate the future.

Vice-President J. V. Neubert:—Mr. Wendt, I was just going to make a remark on the Committee. Possibly you are not aware that the Committee here is three, but in personnel there are thirty-three, exactly. We will increase or decrease that just exactly the way the Committee may feel. If they want it approximately 3000, we will be glad to give it to them if they need more power.

Is there more discussion or remarks? If not, this Committee, as I told you, is not as small as it appears here, but there are thirty-three. They can be increased as they feel satisfied. They are a very fine body in character, ability and otherwise. They are excused with the thanks of the Association (Applause).

DISCUSSION ON GRADE CROSSINGS

(For Report, see pp. 65–94.)

Mr. Frank Ringer (Missouri–Kansas–Texas):—The report of Committee IX is printed on page 65 of Bulletin 329.

The first subject under the head of Revision of Manual is on page 67. The A.R.A. Joint Committee on Grade Crossing Protection, on which the Construction and Maintenance Section is represented by five members of Committee IX, took action on May 14, 1930, recommending the continued use of the present standard automatic flashing light and wigwag crossing signals, with the following changes and additions.

I will not read those changes and additions because they are set out on the plans which are recommended. The principles, as you will observe from the Bulletin, are of such a nature that they involve revisions of the former standard plans for signals.

The American Railway Association at special session held at Chicago on May 15, 1930, adopted a resolution as follows: "Resolved that the recommendations relating to signs and signal devices be recommended as standard practice."

It was understood by the Joint Committee that the representatives of the A.R.E.A. and of the Signal Section would cooperate in preparing revised plans incorporating these recommendations and would submit them for the approval of the A.R.E.A. and Signal Section with a view to their adoption by the A.R.A. as standard practice.

The Committee and representatives of A.R.E.A. Committee X, and of Committee XII of the Signal Section have prepared revised plans as shown in Fig. 1 to 13, inclusive, with accompanying directions.

Fig. 1, Advance Warning Sign, is identical with Fig. 6, page 664, 1929 Manual, with addition of directions, no change in the sign itself.

Fig. 2, the Crossbuck Sign, is identical, no change whatever, the only purpose being to incorporate it in an orderly way in these plans and change the number. It had another number and is shown here as Fig. 2. There is no change whatever in the standard as adopted last year.

Fig. 3 to 6, inclusive, are for wigwag signal, Fig. 7 to 10, inclusive, for flashing light. Fig. 3, 4, 7 and 8 are designed for locations at side of highway, and Fig. 5, 6, 9 and 10 for locations in center of highway or street. The sign showing number of tracks has been added in accordance with the action of the Association shown on the plan for Crossbuck Sign, and also the provision for bell when required. The alternate reflector and light type stop signs are shown for each location.

It is the view of the Committee in recommending these two alternates that the signs "Stop When Swinging" or "Stop on Red Signal" should be used at country locations where electric current is not available; and in urban communities, near towns and other locations where commercial electric current is available, that the light type Stop sign is preferable. But they are alternate and either could be used.

In addition to the recommendations quoted above the Joint Committee at a meeting May 14, 1930, recommended that each flashing light unit be

equipped with a background, and that the minimum vertical clearance of the flashing light units or wigwag disc be 7 feet above the surface of the roadway, which features are incorporated in the plans. Otherwise the signals are similar to present standards 4, 5 and 7 as printed on pages 662, 663 and 665 in the 1929 Manual.

The plan for the center of road installation, the layout plan as shown in Fig. 13 on page 80, is a revision of Fig. 8 of the 1929 Manual to show provision for widening paving slightly in order to give unobstructed passageways for vehicles at the usual speeds, as recommended by the National Safety Conference which was held in Washington last year.

The Committee recommends that the plans for Highway Crossing Signs and Signals, Fig. 1 to 13 inclusive, with accompanying directions, be approved by the Association and printed in the Manual in lieu of the directions and in lieu of the Fig. 3 to 8 inclusive appearing in the present Manual.

President Brooke has just handed me a written discussion which I had not seen before, commenting on the report of Committee IX - Grade Crossings, contained in Bulletin 329, submitted by Mr. Benjamin Elkind, Chief Draftsman of the Erie, from which following quotations are taken:

"Appendix A, Fig. 5, 6, 9 and 10, show highway crossing signals for location in center of the highway. The lack of illuminating the bases is a dangerous hazard. Would recommend that a light be attached to the signal to adequately light up the base at all times.

Fig. 13, page 80, shows a change of pavement of 200 ft. from the center line of the outside track for an installation of a signal on the center of road. This distance appears very long when one considers that only 75 ft. is provided in elimination work, in the state of New York, from the ends of center columns to normal width of pavement. If the signals are sufficiently illuminated, I believe that the distance shown in Fig. 8, page 666, 1929 Manual, which is 100 ft. from outside rail to normal width, is adequate.

"Fig. 7 and 9 are flashing light signals with a reflector lens sign of 'Stop on Red Signal.' I assume that the light is the signal and operates and flashes red when a train is in the circuit. The sign suggests other colors and I believe that it affords slight protection to motorists inflicted with color blindness. I suggest the sign should read 'Stop When Lights Flash'."

Of course, there are slight variations suggested in these plans. I should explain to the Association that these plans were worked out in conjunction with the representatives of the Signal Section. It is very largely a signal engineering matter, technical, and necessarily these changes represent compromises, a number of compromises, in fact.

After discussions with the members of the Signal Section Committee, your Committee believes that these are the best plans which can be presented at this time and we feel they should be adopted as standard.

At the convention of the American Railway Association which was held in Chicago last year, they displayed pictures, enlarged views of various kinds of highway crossing protection as installed at many crossings in the United States, and the lack of uniformity was startling. They displayed almost every kind of a crossing signal one could imagine. It certainly will be a great advantage to the driver of the motor vehicle driving over the roads of the country if such signals can be standardized as rapidly and as much as possible. It is toward that end that the committees, your Committees IX and X, the Committee of the Signal Section, and the Joint Committee of the American Railway Association, are working.

The President:—Will you state the motion again, Mr. Ringer, so it will be understood?

Chairman Frank Ringer:—It is moved that the plans for highway crossing signs and signals, Fig. 1 to 13, inclusive, with accompanying directions, be approved and printed in the Manual in lieu of the matter now printed in the 1929 Manual.

The President:—The motion is before you, gentlemen. Is there any discussion? If not, those in favor of the motion will please say "aye"; contrary, "no." It is carried.

Chairman Frank Ringer:—The report on Subject No. 2 is printed on page 81, Comparative Merits of Various Types of Grade Crossing Protection, collaborating with Committee X, Signals and Interlocking, the Safety Section, A.R.A., and the Highway Research Board. It will be presented by Mr. J. G. Brennan, Chairman of the Sub-Committee.

Mr. J. G. Brennan (New York Central):—The Committee has considered twenty different types of highway railroad grade crossing protection, and they are so listed in the report. I will not attempt to read each one. It is another argument in favor of standardization. The Committee recommends that the report be received as information.

The President: Is there any discussion? If not, it will be so received.

Chairman Frank Ringer:—On Subject 3, Economic Aspects of Grade Crossing Protection in Lieu of Grade Separation, this subject involves the collection of cost data and the analysis thereof. This Sub-Committee reports progress.

Subject 4, Methods and Forms for Classifying Highway Crossings of Railways and Forms for Recording and Reporting Highway and Railway Traffic Over Highway Grade Crossings, collaborating with Committee XI—Records and Accounts. Mr. Brink, the Chairman of the Sub-Committee, is absent.

You will observe from the matter printed on pages 84, 85, 86 and 87 that these are forms. At the last meeting of the Committee, it was felt that these forms should be submitted as progress at this time, and further study be given before recommending for printing in the Manual. They are offered as information.

The President: They will be so received if there is no objection.

Chairman Frank Ringer: Subject 5, Method for Developing and Evaluating Relative Benefits to the Public and Railways from Grade Crossing Protection or Elimination. This subject will be presented by Mr. Korsell, Chairman of the Sub-Committee.

Mr. A. E. Korsell (Chicago, Rock Island & Pacific):—The subject assigned to the Sub Committee is along the same lines considered by the Association in 1929. The Committee, after further consideration, has been unable to develop and formulate a method for evaluating the relative benefits from grade crossing protection or elimination other than the principles previously formulated and printed in the Manual.

It is the conclusion of the Committee that the principles as already adopted by the Association and as printed in the Manual embody the proper method for developing and evaluating relative benefits to the public and railways from grade crossing protection or elimination.

I move that the conclusion be approved by the Association.

Mr. W. M. Ray (Baltimore & Ohio):—In the matter of information desired as to the necessity of the elimination of grade crossings, there are two points or two sets of information that have always to be looked up. One relates to the matter of visibility, that is, ability to see approaching trains, and the other is the traffic count.

It would seem to be valuable if the Committee could make some suggestion on the basis of the traffic count indicating at what point grade separation becomes a serious consideration. In hearings before the controlling commissions, a usual question is, if the railroad company affirms that the traffic count does not justify grade separation, "How much traffic would justify grade separation?"

There are many other considerations that enter into that question, of course, but it is suggested that if the Committee could fix some range based on traffic count within which consideration of grade separation is proper, such information would be useful.

Chairman Frank Ringer:—The Committee will bear that in mind and be glad to give consideration to the point the gentleman brings up in next year's study.

The President:—The question is on the adoption of the conclusion at the bottom of page 88. Is there any further discussion?

(The motion was put to a vote and carried.)

Chairman Frank Ringer:—Subject 6, as printed on page 89, is "Provision which should be included in Uniform Statutes Governing Highway Grade Crossing Protection or Elimination." This, we think, is an interesting report and is to be presented by the Chairman of this Sub-Committee, Mr. Blum.

Mr. Bernard Blum (Northern Pacific):—In this study the word "elimination" is broadly used to include grade separation. Thus far the railways of this country have had to bear the burden of meeting grade crossing problems. We feel that the time has come, due to changes in conditions, highway traffic, the importance of buses and other forms of competition with the railroads, that such cost should be divided according to the benefits received and should be governed by definite statutes, these statutes to be uniform and to embrace certain broad principles. The increase in highway traffic has brought about, as we have said, a new condition. We also feel that the railroad commissions in the various states are best qualified to act as mediators and pass on the different ideas that may come up.

We have endeavored to set forth a list of principles that should be the basis of such uniform laws or statutes governing the division of cost and have summarized these principles in the conclusions which start in the middle of page 90 of Bulletin 329, which I shall read: "Statutes governing highway grade crossing protection or separation should include the following provisions. (By 'Railroad Commission,' as referred to, it is intended to designate the state regulatory body having control over railroads.)

"1. The Railroad Commission should have jurisdiction over crossing protection and grade separation projects on all public highways.

"2. The apportionment of expense for crossing protection and grade separation should be:

"(a) For highways forming part of the Federal Aid System, between Federal Aid, the Highway Department and the Railroad.

"(b) For county highways, between the county, the state and the railroad.

"(c) For city streets, between the city, the county, the state and the railroad.

"3. The Railroad Commission should be authorized and required to prescribe uniform warning signs for use at grade crossings.

"4. No new grade crossings should be constructed except on order of the Railroad Commission following a hearing.

"5. The Railroad Commission should be empowered to designate 'Stop' crossings and the statutes should provide for the creation of same and penalties for failure to stop at such designated crossings.

"6. No grade separation project and no new overgrade or undergrade crossing should be constructed except with the approval of the Railroad Commission.

"7. The Railroad Commission should prescribe the physical characteristics for new crossings with respect to approach grades, width of approaches and planking, etc.

"8. State Highway Departments, counties and municipalities should be empowered to negotiate grade separation projects or new crossing projects involving under or overhead structures, with railroad companies, subject to approval of the Railroad Commission."

Here, before reading the recommendation, I will say that the text of the report on pages 89 and 90 forms a thesis to bear out the reason for these recommendations. The recommendations of the Committee are as follows:

"The Committee recommends that the Conclusions be approved by the Association and that the report be submitted to the A.R.A. Joint Committee on Grade Crossing Protection for further action by the American Railway Association."

We make that in the form of a motion.

The President: The question is before you, gentlemen. This is a very important subject and I hope that there will be some discussion of it.

Mr. J. V. Neubert (New York Central): On page 91, under paragraph 7, it says: "The Railroad Commission should prescribe the physical characteristics for new crossings with respect to approach grades, width of approaches and planking, etc."

I think the word "planking" possibly may be misleading because there are so many different forms of construction in crossings today.

Mr. Bernard Blum: I think what the Committee had in mind was that if new grade crossings should be established through orders of railroad commissions, the width of the planking that might be required on such a crossing would be subject to the review of the Railroad Commission. As a matter of practice, the railroads and the cities or states or counties would confer and probably work out the problem between them. But if any difference of opinion ensued, the Railroad Commission would have the final say on that question; also as to the type of planking that might be required, whether wood, concrete or steel.

Mr. W. L. Roller (Chesapeake & Ohio):—I should like to suggest, under paragraph 8, that the railroad be included as empowered to initiate separation of grades.

Mr. O. E. Selby (Cleveland, Cincinnati, Chicago & St. Louis):—In the conclusions on page 90, No. 2, the apportionment of expense for crossing protection and grade separation is given, but no mention is made of the proportion which each of the bodies mentioned there should pay. Is it to be inferred that it is the intention to have the apportionments given here to be equal? If that is the case, in (a) you would have the railroads bearing one-third, in (b) one-third, and in (c) one-fourth.

Mr. Bernard Blum:—I may answer that and say no, it was not the intention that it should be uniform. As a matter of fact, we have not said here in any way how that expense should be divided. That would be the subject of Sub-Committee No. 5. The subject of the division of costs was given to No. 5 and they have referred to the Manual which says that the division of expense should be evaluated on the basis of the benefits to the respective parties at interest. For instance, under (a), (b) or (c), that percentage might vary. That is where the Railroad Commission is to come in and act as a quasi-public body to make such division of expense. I do not believe that we would care to set forth here any definite percentage that a railroad company should bear. In some cases it might be totally unfair to the railroads to bear, for example, one-third. Yet, if we set that forth as a principle which was subscribed to by all members of the A.R.A., the railroad in this particular case might be helpless. We cannot get away from the benefits that accrue to the individual members.

In answer to the previous speaker, on No. 8, I do not believe, as it is worded, that it prevents the railroad company from initiating projects. It has to start out with one party or the other at interest. We started it with the public body to negotiate with railroads. I do not believe that the form of English of No. 8 as written prevents the railroad company from being the initiating unit of such a conference.

The President:—Is there any further discussion? If not, those in favor of the motion will please say "aye." Contrary, "no." It is so ordered.

Chairman Frank Ringer:—Subject 7 is: "Specifications for Location, Height and Illumination of Signs Protecting Grade Crossings, collaborating with Committee X—Signals and Interlocking." The subject matter of the report is offered as information.

The President:—If there is no objection it will be so received.

Chairman Frank Ringer:—The last subject is "(8) Classification and Forms for Recording and Reporting Highway Grade Crossing Accidents with a View to Determining the Relative Extent of Contributory Causes and Merits of Protective Devices, collaborating with Committee X—Signals and Interlocking, XI—Records and Accounts, the Safety Section, A.R.A., and the Association of Railway Claim Agents."

This subject will be presented by Mr. M. V. Holmes, the Sub-Committee Chairman.

Mr. M. V. Holmes (Atchison, Topeka & Santa Fe):—The work of this Committee was carried forward from last year in order to collaborate with the bodies designated. As a result of that work, the form on pages 93 and 94 has been evolved and approved by the other bodies and is now recommended for adoption by this Association as recommended practice. It is so moved.

The President:--The motion is before you, gentlemen. Is there any discussion? If not, those in favor of the motion will please say "aye"; contrary "no." The motion is carried.

Chairman Frank Ringer:—Since the last convention, your Committee has lost a very able member and also Chairman of the A.R.A. Joint Committee, the late W. J. Towne, Chief Engineer of the Chicago & Northwestern Railway Company.

The President:—This Committee deals with a subject which is of great importance at the present time. They have done excellent work. The Committee is relieved with the thanks of the Association (Applause).

Mr. Benjamin Elkind (Erie), by letter:—Appendix E and F, pages 88 to 91: These appendices and also the Manual referred to therein, in connection with the element of benefits and the apportionment of cost mentions the railroads and the public only. A more careful consideration should be given to buses and trucks carrying freight. It is apparent that these motor transports are greatly benefited by crossing protection or elimination. Avoidance of stops, faster schedules and the decrease of crossing hazards and the savings contingent thereto will increase their earnings. They use the highways for the same purposes as the railroads use their private right of way. I believe that they should be considered as an additional party to an elimination project. Their benefits should be emphasized as well as their non-participation in the cost of an elimination.

Mr. G. S. Fanning (Erie) by letter:—Of the twenty types of grade crossing protection listed, in only one case, No. 20, is there any indication that any of these types of protection has ever been actually used. It is to be hoped that this report will be continued to indicate to what extent any of these various devices are in practical use and the experience of the users. Rail publications abound in manufacturers descriptions of these various devices, but with an almost complete absence of any indication that they are actually in successful use.

Appendix D—In the outline of information to be obtained at each grade crossing, Item 16, the classification seems to be rather strict. I should be inclined to think that the visibility of 1000 ft. both ways along the track within a distance of 100 ft. both ways along the highway from the crossing would be considered "good" rather than "fair", and that anything better than this would be "excellent".

The summary on page 86, which indicates that for each class of highway the number of crossings are to be classified into 39 different classifications, seems to me to involve a lot of unnecessary work. The important classification would seem to be with regard to the type of protection required and as to relative necessity for elimination, in determining which a combination of many of the factors listed must be given consideration.

DISCUSSION ON BALLAST

(For Report, see pp. 99–106.)

Mr. A. P. Crosley (Reading):—The report of Committee II, Ballast, is found in Bulletin 329, pages 99 to 106, inclusive. The Committee was assigned six subjects. They have reported in the Bulletin upon three.

The first subject is Revision of Manual. Mr. M. I. Dunn, of the Chesapeake & Ohio, is Chairman of the Sub-Committee and will present the report.

Mr. M. I. Dunn (Chesapeake & Ohio):—This Sub-Committee has had several subjects dealing with the revision of the Manual. Special attention has been given to proper ballast sections, but the work has not progressed sufficiently to warrant any recommendations at this time.

The Committee would respectfully call attention to the fact that in the Bulletin sent out showing revision of the Manual, the revised specification for prepared gravel ballast has been omitted. This will be covered this year. This is submitted as information only.

The President:—It will be so received, if there is no objection.

Chairman A. P. Crosley:—The report on the second subject, Specifications for prepared gravel ballast, including best method of testing for hardness, abrasion and resistance to weathering, will be found in Appendix A, page 100. The Committee has been attacking this problem in two parts: (1) consideration of requirements and methods of tests for grading and cleanness, and (2) consideration of methods of testing and requirements for hardness, abrasion and resistance to weathering.

The first subdivision was reported on at last year's convention and the recommendations were adopted. It is proposed to canvass the railroads and the producers in localities where gravel ballast is used to determine to what extent the specifications are used.

Considerable preliminary work has been done on the second part of the problem in the laboratories of the National Sand and Gravel Association under the direction of Mr. Stanton Walker and the Iowa State College under the direction of Professor W. L. Foster.

Laboratory tests alone will not permit the fixing of specification limits. It is necessary to have the laboratory work supplemented by service records of field performance of gravel ballast. Requests for information along these lines will be sent to various roads, and it is hoped that they will respond with as much information as possible on the specific gravels for which information is requested, rather than on gravel ballast in general.

In connection with this report as well as the next one, I should like to call the Association's attention to the fact that Professor Stanton is connected with Carnegie Institute of Technology, Professor Foster with Iowa State College, Mr. Stanton Walker with the research laboratory of the National Sand and Gravel Association, and Mr. A. T. Goldbeck with the research laboratory of the National Crushed Stone Association. These gentlemen have been able, through the facilities at their respective places, to do considerable work for this Association and this Committee in particular, that we otherwise would not have been able to secure.

I should also like to say that some of the railroads have sent in samples of ballast as received from the producers, for analysis. These have been of assistance. If any roads care to assist the Committee, shipping instructions will be given. What the Committee would like to have is samples of ballast which for one reason or another roads feel have not proved satisfactory, so that the Committee could determine, if possible, the cause of failure.

The next subject, Specifications for Stone Ballast, including best method of testing for hardness, abrasion, and resistance to weathering, will be found in Appendix B, page 101. Mr. H. M. Righter, Chairman of the Sub-Committee, will present the report.

The President:—Appendix A is submitted as information only If there is no objection it will be so received.

Mr. H. M. Righter (Erie):—Your Committee has reviewed the Specifications for Stone Ballast appearing in the 1929 Manual and feels that these specifications should be revised and rearranged. It was felt advisable to separate the test requirements from the methods of test. By this arrangement the test requirement portion could be written directly into the specifications of an individual railroad and the test methods referred to as those of the A.R.E.A. Some of the articles have been copied from the old specifications. Those revised have been rewritten, keeping in mind the old specifications and conforming to them as much as possible, making only such changes which the Committee felt were an improvement over the old.

There is one point which the Committee desires to have stricken out; on page 103, following Section 17, there is Note 1, giving typical values for physical characteristics of high quality stone. These values were taken from the old specifications as the Committee had not had an opportunity to verify them. It was assumed that these values were determined from experiments prior to their original adoption. The Committee has made some preliminary studies in which they find that the cementing value is decidedly wrong. They therefore ask that the figures shown be stricken out. The Committee does not care to offer substitute figures pending further investigation. The Committee moves that this specification be adopted and included in the Manual.

The President: In order that an opportunity may be given to discuss the various topics of the specifications I suggest, Mr. Righter, that you simply read each heading as "General Characteristics," etc., and pause after reading the heading and give those in the audience a chance to discuss that specification if they so desire.

Mr. H. M. Righter:—The first heading is "General Characteristics." 2, Apparent Specific Gravity and Weight per Cubic Foot; 3, Absorption; 4, Toughness; 5, Percentage of Wear; 6, Cementing Value; 7, Soundness; 8, Frequency; 9, Selection of Samples; 10, Averaging; 11, Place of Tests. Then follows the production requirements: 12, Size; 13, Handling; 14, Cleaning; 15, Defect Found After Delivery; 16, Inspection; 17, Measurement.

Mr. Frank Ringer (Missouri-Kansas-Texas):—I would like to ask the Committee a question as information as to paragraph 15 and as to the whole specification, if it meets the approval of the manufacturers of crushed stone.

Mr. H. M. Righter:—We can not say that as a general statement, no.

Mr. Frank Ringer:—I understood the Committee to say they had had discussions with the manufacturers of stone and that some of them had been cooperating with the Committee.

Mr. H. M. Righter:—It has not had organic consideration, of course, but it has had considerable consideration and it probably represents their opinion as well as ours.

Mr. Frank Ringer:—The reason I ask about paragraph 15 is I assume of course they gave consideration to the equity involved in that paragraph. It seemed it might possibly meet with opposition from the manufacturers of crushed stone.

Chairman A. P. Crosley:—In answer to that, Section 15 is copied directly from the existing paragraph in the Manual with no change in it whatsoever, so that there has been, we have felt, ample time for any objections on the part of any manufacturer if he thought he was being dealt with unjustly.

Mr. J. V. Neubert (New York Central):—The question raised by Mr. Ringer possibly may be summed up in his and other minds. The National Crushed Stone Association I believe has a very able member on this Ballast Committee, and possibly Mr. Goldbeck, who is very familiar with the entire condition, may enlighten us on the question Mr. Ringer asked.

Mr. A. T. Goldbeck (National Crushed Stone Association):—I think I can answer that briefly by saying that I do not know of any objection having been raised by the crushed stone industry.

Mr. H. M. Righter:—The next is Test Methods, 18, Apparent Specific Gravity; 19, Weight per Cubic Foot; 20, Absorption; 21, Toughness; 22, Soundness; 23, Wear Test; 24, Cementing Value.

The President:—Motion has been made and seconded for the adoption of these specifications to replace those now in the Manual. Is there any further discussion?

(The motion was put to a vote and carried.)

Chairman A. P. Crosley:—There is one typographical omission which I think is perfectly clear and which, of course, will be corrected in the printing. Under 18, on page 103 there should be a C. in parenthesis—(100–110 deg. C.). The Fahrenheit is given right before.

The Committee has also just received a communication from Mr. G. S. Fanning, Chief Engineer of the Erie, on this subject, which they will take under consideration.

The next subject is Shrinkage of Ballast. This Sub-Committee expected to submit information on the tests which have been conducted, but due to circumstances beyond its control was prevented. Your Committee has been working on this assignment for the past few years and, as stated at previous meetings of the Association, the Committee has been endeavoring to secure the assistance of railroads on this subject. This assistance was to be in the nature of certain tests on certain types of structure to determine the shrinkage of ballast. Some of the roads have responded to the appeal.

Your Committee has had knowledge of projects on many roads on which tests could have been conducted, but for some reason or other the roads did not seem to care to undertake these tests. All of the tests now under observation will have run out before another meeting of this Association, and it is the hope of the Committee to have results available for presentation at that time.

Unless some additional roads come forward and offer to conduct additional tests, the Committee will be forced to submit its report and ask for discontinuance of the subject, feeling that they have done practically all possible on

the assignment but realizing fully that insufficient data have been obtained upon which any conclusions of value could be based.

The next subject, relative service life of stone, slag and prepared gravel and other kinds of ballast, will be presented by Mr. M. I. Dunn, in the absence of the Chairman of the Sub-Committee who is ill.

Mr. M. I. Dunn (Chesapeake & Ohio):—The Committee has given this subject serious consideration. A questionnaire was prepared and sent to the railroads. From the replies received, it was evident that little could be hoped for, at least for the present, by attacking the subject in its entirety. The Committee, therefore, has asked the Board of Direction to reassign the subject in a modified form or as a division of the main subject. It is hoped that by working along this line some valuable information will be obtained.

The Board of Direction has assigned the subject as requested, and the assignment now stands for study and report on the comparative cost of maintaining track with various kinds of ballast. This is submitted as information.

The President:—It will be so received.

Chairman A. P. Crosley:—Report on the last subject will be found on page 106, Appendix C, Determine the answer to the Question: "What is Ballasted Track?"

The Committee has reviewed the work on this assignment which was presented before the 1930 convention, and through correspondence and conferences with many people we found that there was widely differing opinion on this subject.

In the Manual is the definition for track, ballast, sub-ballast and top-ballast. The Committee therefore submits the following definition: "Ballasted track is track to which ballast has been applied in its proper position." The word "relative" as appearing in there has been taken out.

It is recommended that this be adopted for publication in the Manual.

Mr. C. W. Baldridge (Atchison, Topeka & Santa Fe):—It appears to me that the Committee has given us a definition instead of an answer to the question. I think what should be given here is discussion of what really amounts to ballasted track and not just a definition of ballast.

Chairman A. P. Crosley:—We tried to do that last year and after calling attention to certain information we drew a definition based very largely on what the Committee felt was ballasted track, and if you will recall it met with such opposition that it was referred back to the Committee. After studying the subject again, we merely referred to the report of the 1930 convention rather than copy or even try to elaborate on that report of last year.

Mr. J. C. Irwin (Boston & Albany):—I was one of the principal opponents of the definition last year because I thought that the Committee made too much effort to describe the amount of ballast that should be in the track in order to consider the track ballasted for various conditions of traffic. It is a very involved subject and I raised the question why we needed a definition for what is ballasted track in the Manual at all. Having a definition for a track and a definition for ballast, it seems to me that it does not add anything to our necessary information in the Manual to have a definition for ballasted track. Therefore, I first advocated that such a definition be not put in the Manual. Anyone who has dealt with the various subjects that come up in connection with ballasted track for valuation purposes as well as for other

purposes, it seems to me, will find the subject is too much involved to try to describe it in detail. The question of whether the track is a main track or a passing track or a change of one kind of track to another in connection with change in service involves the subject so much that I think the definition cannot be properly written. Therefore, my view was that we do not need such a definition, and I think possibly the Committee may have prepared the definition from their sense of duty on account of its having been assigned. But they have made the recommendation and apparently it can do no harm in this form. I think it would be likely to do harm if we tried to do it more in detail.

Mr. C. W. Baldridge:—It seems to me that the assignment of this subject is really at fault. If we want to get at this subject it probably might be done by asking the Committee to determine relative values of different depths of ballast, or something of that nature. The subject as worded here appears to me to be an impossible subject. Nothing can be given but a definition, and I do not believe we need it.

Chairman A. P. Crosley:—The Committee revises the motion and recommends the definition be received as information only.

Mr. J. C. Irwin:—I second that motion.

The President:—You have heard the motion, gentlemen. Is there any further discussion?

(The motion was carried.)

Chairman A. P. Crosley:—That completes the report of the Ballast Committee.

The President:—This completes the report of the Committee on Ballast. It has done excellent work and has given us some fine specifications on stone ballast. The Committee is discharged with the thanks of the Association (Applause).

Mr. G. S. Fanning (Erie) by letter:—Appendix B.—Specifications for Stone Ballast. I am not in sympathy with the Committee's effort to separate the test requirements from the methods of test. The real specification is contained in the first paragraph and all the rest of the specification is an elaboration of this specification to indicate how the different qualities shall be measured. In my opinion the specification would be improved by bringing the test methods forward to follow the general characteristics and let each of the articles 2 to 7 be incorporated at the end of the corresponding test article.

There is some question as to the value of the cementing test. The cementing quality is important on stone used for highway surfacing, where high values for this particular quality are desired, but it is questionable whether any stone, which was otherwise satisfactory for railroad ballast, has been or would be rejected on account of a high cementing value. The railroads of the group with which the Erie Railroad Company is associated have recently adopted a new ballast specification which completely eliminates any requirement as to cementing value.

The apparent specific gravity requirement is only a duplication of the weight requirement and is one step in testing the weight. I see no necessity for specifying both.

There is also some question as to the importance of the absorption test which has been included by the Committee.

In Article 10, inasmuch as the number of tests to be averaged for each of the qualities is the same, the amount of printing could be reduced by making this section read: "For obtaining the values for physical tests, the average results of five specimens shall be taken".

Article 12. Using only a laboratory test as a specification for the size of stone for ballast, as is done here, very often results in unnecessary arguments with and expense to the quarry. The natural thing for a quarry operator to do, where maximum and minimum sizes of screens are specified, even though they may be called laboratory screens, is to use the same size screens in his operation. As the results of the operation of screens in the plant depend upon the angle at which the screens are set and the speed which the stone is passed over them, in addition to the size of the openings, results will almost invariably differ from what are obtained by the use of laboratory screens with the intensive agitation which always accompanies this use. I believe that the specification should state definitely what size stone we are trying to get, then give some indication as to how this may be obtained at the quarry, followed by the laboratory test. A typical specification of this kind would read:

"Stone for ballast shall be broken into fragments which range with fair uniformity between a maximum dimension of 2½ in. and a minimum dimension of 1 in. Usually this specification will be met by using a 2¾ in. round hole screen to retain larger sizes and a 1½ in. round hole screen to pass smaller sizes.

"Test for Sizes: (Maximum). A sample weighing not less than 150 pounds shall be taken from the ballast as loaded in the cars and placed in or on a screen having round holes two and three fourths (2¾) inches in diameter. If thorough agitation of the screen fails to pass through the screen 95 per cent of the fragments, as determined by weight, the output from the plant shall be rejected until the fault has been corrected.

"(Minimum). A sample weighing not less than 150 pounds shall be taken from the ballast as loaded in the cars, weighed carefully and placed in or on a suitable screen having round holes one and one-half (1½) inches in diameter. The screen shall then be agitated until all fragments which will pass through the screen have been eliminated. The fragments retained in the screen shall then be weighed and if the weight is less than 95 per cent of the original weight of the sample, the output of the plant shall be rejected until the fault is corrected."

In Article 18, Paragraph (3), apparently something has been omitted after "5 in. (12.7 cm.)".

In Article 23, under Procedure 3, the size of the mesh 0.005 in. does not check with the corresponding metric dimension 0.16 cm. The dimension in inches is obviously in error.

A

DISCUSSION ON TIES

(For Report, see pp. 235-279.)

Mr. W. J. Burton (Missouri Pacific):—The report is the first one in Bulletin 332. The first subject is that of Anti-Splitting Devices. This subject has been under investigation for two or three years. The report will be presented by Mr. E. L. Crugar, Chairman of the Sub-Committee.

Mr. E. L. Crugar (Illinois Central):—The report of the Sub-Committee on Anti-Splitting Devices will be found under Appendix A on pages 236 and 237 of Bulletin 332. Five conclusions are given, together with plans and specifications for irons.

I move that the conclusions and the drawings be adopted for inclusion in the Manual.

The President:—I suggest that you read the conclusions, Mr. Crugar, and pause after each one to permit of discussion.

Mr. E. L. Crugar:—Conclusion No. 1: "All hard or broad leaved woods are subject to checking and should have anti-splitting devices applied."

The President:—Is there any discussion on Conclusion No. 1?

Mr. E. L. Crugar:—That, of course, means that all hardwood ties would have one of the types of irons shown here, either one iron or two irons. In some cases it is necessary to place two. I have seen some where three would be necessary.

Conclusion No. 2: "Anti-splitting devices should be applied prior to or at time the ties are delivered to the yard and stacked for seasoning." The object of that conclusion is to get the iron in the tie as soon after cutting as is practicable.

No. 3: "Anti-splitting devices should be so placed as to cross at right angles the greatest possible number of radial lines of the wood."

No. 4: "Shape and size." Two sizes are recommended, one for sizes 3A, 4, 5 and 6, and one for sizes 0, 1, 2 and 3, there being a difference in the size of irons to meet the differences in the sizes of ties.

Mr. C. C. Cook (Baltimore & Ohio):—Under shape and size, I note that it states the thickness of the iron be not heavier than 13 gage. A great many of the irons that are now used are 11 gage, with the design as is now rather generally used, which I note the Committee has here changed.

I should like to know from the Committee whether the change in the design, that is, in the shape of the iron, justifies the decrease in thickness, and whether the same strength of iron was being secured in this design as we got with an iron of 11 gage, and whether any tests have been made by the Committee to support the recommendation.

Mr. E. L. Crugar:—We have had tests at both the Altoona shops and the Burnside plant.

The tests at the Burnside plant particularly demonstrated that the 13 gage could be driven, and the Altoona test, which was a force test, demonstrated that the 13 gage was of sufficient strength. Therefore, the Committee reached the conclusion that any iron that was of sufficient thickness and strength to drive into the hardest wood was of sufficient strength to perform the function

ior which it was placed. Therefore we recommend the 13 gage. Individual roads can go to a heavier gage if they think it advisable.

Mr. C. C. Cook:—I believe that the test as to whether the iron will drive in the hardest wood is indicative of the strength of the iron, but we have had some difficulty in bending of irons with 11 gage. My fear is that by reducing to a 13 gage, with the kind of drivers that you have in a tie yard, you may have a great many more irons that will not be completely driven and will bend under the hammer if not struck directly as they might be at the laboratories.

Mr. E. L. Crugar:—I think there is one other point in connection with the thickness that I did not mention and that should have been mentioned. The thicker you get the iron there is a possibility of greater injury to the timber. It is possible to get the iron so thick that you cause the wood to split.

The President.—Is there any further discussion?

Mr. E. L. Crugar:—No. 5, "Anti-splitting irons shall be made from open-hearth new billet steel of a chemical composition which shall be within the following limits:

Carbon	.25 to .35
Manganese	.40 to .60
Phosphorus	.05 or less
Sulphur	.05 or less
Copper	.20 or more."

The President:—The motion is upon the adoption of these conclusions with the accompanying drawings.

Is there any further discussion? If not, those in favor of the motion will please say, "aye." Contrary, "no." The motion is carried.

Chairman W. J. Burton:—The report on the second assignment will be found on pages 238 and 239 under Appendix B. The subject is: "Extent of Adherence to Standard Tie Specifications." The Sub-Committee reporting on this is headed by Mr. Foley, who is not here today. Mr. Crugar will present Mr. Foley's report.

Mr. E. L. Crugar:—This year's report on the Extent of Adherence to Standard Tie Specifications may be summarized by saying that while lack of competition for their supplies resulted in railroads improving their inspection in some cases, there really has developed a betterment in practice which has greatly improved the general quality of cross-ties during the several years the Committee has been examining stocks.

Each year more railroads adopt the standard specifications. This is sufficiently elastic to permit each railroad to provide for only the kind of woods and sizes of ties it desires. By recognizing certain dimensions and fixing standard sizes they are given a market standing which permits their production for any demands which may develop.

No good reason for the use of non-standard designations has as yet been discovered by the Committee, and all railroads not using them are urged to adopt them for whichever standard sizes they use. Of the 160 Class I railroads in the United States, information is available regarding the ties, the tie size and designation, of 108, and only nine railroads, or eight per cent, are non-standard. The two Canadian trunk lines are not included. They are both non-standard. When all that may be required for a non-conformist railroad to become regular is to call a 7x8 tie Size 4 instead of No. 2, it would seem as though the change to standard, simplified practice could not present any

real difficulties. Reluctance to any change may have had a shadow of justification in 1921, but the A.R.E.A. specifications for ties have demonstrated their worth in stabilizing the industry of their production and adherence to them is their doom. This report is offered as information.

Chairman W. J. Burton:—Before we pass that there is one further word I should like to say in addition to what Mr. Crugar has said. The Tie Specification originated by the American Railway Engineering Association is now the American Standard. It is the only one, I believe, of the American Railway Engineering Association which has become the American Standard. We have a Standardization Committee which has among its objects the use of our own specifications and recommendations as standard. I merely want to call attention to the fact that here is one standard which is not only practicable, as proved by its very large adoption, but one which has the sanction of our Association and of the American Standards Association as well. It is the "American Standard" specification.

The Committee believes that the non-adoption of this specification by some railroads, with the situation as it is at present, is undesirable. Every one should adopt it, even though good ties are and can be had under other specifications.

The next subject is that of Substitute Ties. In the absence of the Sub-Committee Chairman, Mr. Clement, I shall ask Mr. Riegler to present this report.

Mr. L. J. Riegler (Pennsylvania):—This report is printed in the Bulletin as Appendix C on pages 240 to 244. It is the usual report on the experience of the different railroads with substitute ties.

On page 245 is shown a tabulation of the tests now found on the different railroads, giving the name of the tie, the location, the date, the number placed in track, the number now in track, ballast, section of rail, and the traffic conditions. This report is offered as information, and I so move.

The President:—Is there any discussion of the report? If not, it will be so received.

Chairman W. J. Burton:—The next subject is to be found on page 246 under Appendix D. Mr. Roach, Chairman of this Sub-Committee, is also absent today. This report is a continuation of the data which were originated three years ago and is based upon the reports made by the railroads to the Interstate Commerce Commission. The form is the same as previously reported, with the exception that this year, for the first time, there is an added column showing the equated gross ton-miles. This equated gross ton-miles is according to the formula approved by the Association last year and is what is commonly known as the Yager formula.

I wish particularly to call attention to Table B, beginning on page 253. The figures in Table B are derived from those reported in Table A. The new column, No. 9, shows the density of traffic on different railroads per mile of track. It is density per mile of track which wears out ties. A certain density of traffic per mile of road, if divided up among two or four tracks, is quite different from the same density over a single-track railroad.

The Committee believes that the information in Table B should be very helpful to railroad maintenance officers in making studies of their results as compared to results of their neighbors.

The data are reported as information and the Committee expects to continue this from year to year.

The President:—If there is no objection, it will be so received.

Mr. J. V. Neubert (New York Central):—I was wondering if the Committee in summarizing this information in the report has come to any conclusion as to what is an average or weighted average life of a treated tie would be. We know pretty conservatively on our own property what the life of an untreated tie is. I believe, if my memory serves correctly, that this Association for a number of years said that a treated tie would average about sixteen years. I believe that those who use treated ties to any extent are satisfied to say that that life is too short. The question was brought up by members, I believe, of the Interstate Commerce Commission to-day, and it is a great problem in regard to valuation. I should like to have the opinion of the Committee, if I am not out of order.

Chairman W. J. Burton:—The reports both to the Tie Committee and to the Wood Preservation Committee indicate that a five-per-cent renewal, which corresponds roughly to a 20-year life, is very reasonable to expect, and that there are certain very well maintained railroads which are consistently renewing less than five per cent. I agree with Mr. Neubert, and the Committee, I am sure would, that sixteen years' life for a properly creosoted tie is too short. The difficulty in getting a better figure than, say, twenty or twenty-five years, is the fact that on many roads creosoted ties have not been used long enough to arrive at the average; that is, they have been in less than even the average. We feel safe in saying that twenty or twenty-five years, under conditions where ties are properly protected from mechanical wear, is not too long to use in estimates. Does that answer your question, Mr. Neubert?

Mr. J. V. Neubert (New York Central):—Yes, I have had that same question up with people who have been very familiar with it and they told me we would not get a conservative average life of treated ties under the end of the second renewal period. You could not conservatively get it on the first renewal or the beginning of the second renewal or not until the end of the second renewal.

Chairman W. J. Burton:—There is some information along that line that will be reported a little later by Mr. Shoup, of the Kansas City Southern.

The next subject is reported under Appendix E on page 260: "Methods and Practices for Proper Seasoning of Ties, with Particular Reference to Increasing the Service Life."

I will ask Mr. Belcher if he will present this report.

Mr. R. S. Belcher (Atchison, Topeka & Santa Fe):—It was the purpose of this Committee to formulate a few concise rules to cover the handling of ties with particular reference to those items of handling which affect the service life. Those rules which are given on page 260 are short and I had better read them as they are here.

(Mr. Belcher read Appendix E on page 260 of Bulletin No. 332.)

Chairman W. J. Burton:—I move the adoption of that.

The President:—It has been moved and seconded that the material offered by the Committee beginning at (A) and embracing all on page 260 be adopted for printing in the Manual. Is there any discussion?

Mr. C. C. Cook (Baltimore & Ohio):—Under the material of the Wood Preservation Committee in the Manual, care of wood after treatment, it rec-

ommends that timber be allowed to season for at least sixty days after treatment. I wonder if this Committee would be willing to accept that in the last paragraph of their recommendation, inserting after "to season and dry" the words "for at least sixty days."

Mr. R. S. Belcher:—The Committee will accept that.

The President:—Is there any further discussion? If not, those in favor of the motion with the slight revision accepted by the Committee, in the rule, will please indicate by saying "aye"; contrary, "no." The motion is carried.

Chairman W. J. Burton:—The next subject is reported beginning on page 261. The subject assigned reads, "Comparison of ties renewed per maintained mile with proper adjustment for rate of application of treated ties since the beginning of their use and for traffic, using the approved traffic unit." The Committee wishes to report progress on this subject and expects to have a more complete report directly on the subject next year. However, the Committee is presenting this year as being of very considerable bearing on the subject, a monograph by one of its members, Mr. S. E. Shoup. I will ask Mr. Shoup to present his report.

Mr. S. E. Shoup (Kansas City Southern):—In presenting this study I wish first to say very emphatically that it was not undertaken with the idea of proving or disproving any particular point or points. It was believed that tie records on the Kansas City Southern were unique and that if any benefit could be derived from a study of these tie records, it should be shared with other carriers. Therefore, the study as presented is based upon facts and no theories have been interwoven at all. A few things about this study are I think worthy of comment.

The Kansas City Southern started the use of creosoted red oak ties in 1909. The study of creosoted red oak ties is based on the insertion of 2,600,000 of these ties put in beginning with 1910 and continuing in varying numbers thereafter. Of this number, approximately 226,000 have been removed. The basis of this study is a report made by the section foreman and shown in Form 1 on page 270. This form is approximately 17 by 22, that is, four letterhead sheets, and is divided down the center with a vertical line. In Fig. 1 as printed on page 270, there are omitted two sub-captions, "Ties placed" on the first horizontal double line, and "Ties removed" over the second horizontal double line.

It is rather an interesting sidelight on this report that in working up this data I came across a great deal of correspondence between the Division Engineers and the Roadmasters because the number of ties removed did not correspond with the number of ties placed as shown on this report.

This data is not dependable from the standpoint of absolute accuracy, but we believe it is as accurate as records of such volume could possibly be. Some inconsistencies had to be ironed out, but there were very few, all things considered.

It should also be considered that the records as given in this study are upon what you might call experimental creosoted ties. Since the first ties were put in track in 1910, considerable improvement has been made in the treating and seasoning of ties, larger tie plates are being used and more of them, also heavier rails. All these things would tend to make an even greater life than the 26 years which this study would seem to indicate, which is the best present guess that can be made on the life of creosoted red oak ties.

Another thing that I should like to mention is the fact that only 3.7 per cent of our creosoted ties have been removed on account of decay, and that 95.3 have been removed on account of rail cutting or other mechanical wear. Along that line we have test sections at two points on our road, using an anchored tie plate as suggested by Dr. Hermann von Schrenk, which seems to be giving very good results in reducing this mechanical wear.

This report also shows the total renewals per mile of track, but in considering that table it must be remembered that only 71 per cent of the total number of ties on the Kansas City Southern are treated as yet. We are using nothing now but treated ties, and in the next few years we will be using 100 per cent treated ties. At the present time, in looking at those figures, you must realize that they incorporate the removal of untreated ties. This is offered as information.

Chairman W. J. Burton:—There is one other table that I want to call attention to, particularly in response to Mr. Neubert's inquiry. It is Table IV on page 268. The interesting thing to note is that of the ties placed in 1910, for instance, up to and including last June, only 32 per cent had been removed from track, that is, after some twenty years; of those placed in 1911, the percentage is only slightly greater; of those placed in 1912, only 32 per cent; of those placed in 1913, 15 per cent; of those placed in 1914, 31 per cent; of those placed in 1915, 22.5 per cent; of those placed in 1916, 10.8 per cent, and then the percentage decreases right along until a very inconsequential number, less than one per cent, have been renewed for each year since 1921. That table indicates that the average life of the creosoted ties, even of those placed in 1910, has not yet been reached. The estimate of twenty-six years' average life, of course, is predicated on a forecast based on some one of the tie renewal curves. It clearly indicates, though, the justification for a raising of the previous figure of sixteen years.

The President:—This is a very interesting study, gentlemen. I am sure it will be found of great value. If there is no discussion, it will be received as information.

Dr. H. von Schrenk (Consulting Timber Engineer):—I should like to take a few minutes to comment on this report and express my appreciation of this very extraordinary contribution.

Probably one of the greatest troubles we have had, particularly in recent years, is to answer the question Mr. Neubert asked as to what is the life of a creosoted tie. We have had to base an answer to that question very largely on numerous arithmetical calculations. We have all been very conscious of the fact that those arithmetical calculations have been very largely in the form of guesses. We have attempted to give an answer to a—what I call, for want of a better term—biological question in terms of arithmetical averages. We have all been conscious of the fact that that was not the true way to go at it, but it was the only way we had.

Unfortunately, as Mr. Shoup stated, there are very few railroads in the United States which were fortunate enough to have records in such shape as to give the proper answer. So far as I know, there are only three roads that, since the beginning of their installing creosoted ties, have marked them in some way or other, by means of notching or, since the advent of the dating nail, marked the year of insertion of each tie laid in the track.

This is the first contribution, I think, that has ever been made, which shows the years of service of individual year's insertions. I should like, therefore, to emphasize it particularly as it leads to a correct answer as to what is the real tie life we are getting, particularly with reference to creosoted ties and untreated ties, both covered in this report. Consequently, it ought to be noted with a great deal of emphasis.

The reason for this is—I want to repeat what Mr. Shoup said—that the section foremen in removing ties made a report of the year of insertion, so that they have an actual record on the Kansas City Southern of the percentage of each year's insertion still in service. We can therefore draw a series of curves, if you please, which will give us eventually, when the ties have reached their biological peak—as shown in the Thorne curve, approximately 60 per cent of the insertion—a true picture of what that tie life actually was.

One very interesting corollary to be followed from the study that Mr. Shoup has presented would naturally be to test the accuracy of the various curves suggested, beginning with the Thorne curve and running through the whole series, as to how we shall interpret per cent of removal in a certain period in terms of actual tie life. It will be a few years longer on the Kansas City Southern before we will be able to do that. Twenty-six years can properly be taken as a conservative estimate of the performance which the earlier insertions seem to indicate.

I want to also emphasize the paragraph that Mr. Shoup referred to on page 268 with reference to causes of removal. I think it is a very remarkable piece of work that we can point definitely to the fact that of the removals made to date of ties which have been lying in the track since 1912, only 3.7 per cent have been removed because of decay. There are still doubting Thomases in the United States who want to know whether creosoting will really preserve ties. There is a lot of discussion going on as to how ties should be treated, and a great many details connected therewith. It is a record of this sort that one can point to with particular pride.

I am reminded of an experience this summer on the French Eastern Railway. When I requested the Chief Engineer to be permitted to go out and see some of the ties laid in 1879 in their track, which have been in service a little over fifty-one years, he said, "You have been out there three times on previous occasions. What do you want to go again for?"

I said, "I want to go out there and get the atmosphere." We went out on this track, the engineers, operating officials, and myself, and we looked at these old ties. All I could think of was to take off my hat and bow deeply to the ties. I wish you could have seen the expression on their faces. That is something to recognize, that there is the possibility of fifty-one years of life. I think the showing of the Kansas City Southern, remembering that the first insertions date back to the years when we really did not know as much as we do about the character of creosoting and did not inspect our materials as carefully and did not protect as carefully against mechanical wear, is a pretty good indication of what we may expect from treatment as now conducted according to the specifications of our Association.

I want to compliment Mr. Shoup for his contribution.

Mr. S. E. Shoup:—If I may say so, I want to answer Dr. von Schrenk in one particular, and that is that I have plotted some other curves showing how

this data I have prepared may be applied, and provided I can get these curves "by" Dr. von Schrenk and the Tie Committee, I hope to present them next year.

The President:—Is there any further discussion on this subject?

This Committee has submitted some excellent information, information that we have all been looking for for a long time, and the comments by such an authority as Dr. von Schrenk will make us all realize, even more than we perhaps have, the great value of records which will enable such studies as this to be made.

The Association is indebted to this Committee for the good work it has done, and it is now relieved with the thanks of the Association (Applause).

DISCUSSION ON WOOD PRESERVATION

(For Report, see pp. 281–312.)

(Vice-President J. V. Neubert in the chair.)

Mr. F. C. Shepherd (Boston & Maine).—The report of Committee XVII, Wood Preservation, is found in Bulletin 332, page 281, on which page your Committee presents four reports, three covering information and one for adoption.

On page 282, Appendix A, report is given on the service test records for treated ties. This report will be handled by Mr. Goodwin, Chairman.

Mr. W. R. Goodwin (Minneapolis, St. Paul & Sault Ste. Marie):—The table of tie renewals per mile maintained on various railroads has been brought up to include renewals for 1929. Reports are submitted covering special test tracks on the Chicago, Burlington & Quincy; Chicago, Milwaukee, St. Paul & Pacific; Chicago & Northwestern; Great Northern; Rock Island; St. Louis & Southwestern, and Soo Line.

I want to call your attention to a misprint on page 286, in the second series of items. Under the heading "Average life of test ties," 4 per cent zinc chloride treatment, fir-sawed triangular, is shown as 117 years. That is a little too much. It should be 17.

On page 287 we start a report on "Rueping treated ties on the Rock Island Lines which is continued on page 289.

It is recommended that this report be accepted as information and the subject continued.

Vice-President J. V. Neubert:—If there is no objection, it will be so received.

Chairman F. C. Shepherd:—The second report of this Committee is found under Appendix B, page 292, Piling Used for Marine Construction.

In the absence of Mr. Atwood, Chairman, Mr. Cook will render the report.

Mr. C. C. Cook (Baltimore & Ohio):—This is a continuation of the inspections of the test pieces that are existing throughout the various coastal waters. There are some references to some recent compounds developed by the Chemical Warfare Service, which will be instituted and continued with these other test pieces. The material is submitted as information.

Vice-President J. V. Neubert:—If there is no objection, it will so be.

Chairman F. C. Shepherd:—The third report, Appendix C, Destruction by Termite and Possible Ways of Preventing Same, is found on page 310. This report will be described by Dr. von Schrenk.

Dr. Hermann von Schrenk (Consulting Timber Engineer):—The report of the Committee on Termites is very short this year. It is printed on page 310. There is very little to add of a practical nature to the report which the Committee made last year except to call attention to the activities of the very efficient Committee on Termite Prevention of California. They have, during the last year, issued another Bulletin which is referred to herein, together with the indication that anybody who is personally interested please communicate with the Chairman in San Francisco.

The Committee further calls attention to the cooperative tests being conducted under the auspices of the United States Bureau of Entomology in Virginia, and in the Panama Canal Zone with all kinds of samples of treated woods, as well as untreated woods, to determine the relative efficiency of these materials.

I want to add just one word to what is printed in the report, and that is that in view of the ever-increasing evidences of termite destruction in the two zones as indicated on the map printed last year, a very large amount of public attention and interest has been stimulated, and as is usual in such cases, all sorts of people have come forward with the euphonious title of "termitologists" and what-not, advocating various remedies for quick extinction, with guarantees or without guarantees to successful treatment.

The matter got to be so significant in California that the California legislature this last year passed an act prohibiting the practicing of any such profession in California without a certificate of efficiency given by a specially appointed commission who were created by that act. This commission is composed of some of the leading members of the California termite investigation committee, and, as a result of their actions, only properly qualified persons can now operate in California. Unfortunately we haven't any such laws in a number of the other states, and the Committee calls attention to the fact that before trusting anybody who may come with claims towards rapid prevention of termites, they had better proceed cautiously and read the recommendations which your Committee made last year, which gives very simple and easily implied remedies, or consult National authorities before proceeding.

This report is offered as information.

Prof. S. N. Williams (Cornell College):—I should like to inquire of Dr. von Schrenk whether the Committee has yet found any satisfactory or better method of handling these insects along the Pacific Coast than the creosoting process.

Dr. Hermann von Schrenk:—In answer to that question, I can say no, as far as the ground inhabiting forms are concerned. It is probably also true of the forms that come into buildings and structures, bridges, telephone lines and so forth, from the air. But, of course, very frequently it is not practicable to use creosote in situations such as that.

The investigation which the California committee is now making is along lines of rather untried methods as yet. One of the most interesting things they have done recently is to suggest the possibility of using arsenic dusts, taking advantage of the observation that practically all members of the workers of the termite group frequently lick each other. That has been observed time and again, and I think in the moving pictures shown last year that was illustrated. The Committee seem to be very hopeful that by introducing a very fine powder into the workings, if you can get it in there, that a good

many of the termites will be covered with this arsenic dust and be licked by their friends and neighbors and result in ultimate destruction. That works in some places, and in other places it will not work. Of course, it applies particularly to buildings that are already in position. Of course, the great demand for effective remedies is not so much in connection with new structures where you can prevent their entrance entirely, but with existing structures. The tearing down of buildings or bridges or power lines is always a very expensive matter, and the replacement cost, of course, is correspondingly higher. But for ground work there is nothing yet that has been found as efficient a protection as creosote impregnation.

Prof. S. N. Williams:—It seems to be, then, a continuing fight to the finish between the different orders of marine insects.

Dr. Hermann von Schrenk:—Marine as well as land insects. As a prophet recently said, it is coming to be a fight to the finish between the insects and the human race.

Chairman F. C. Shepherd:—The last report of this Committee is shown on page 310, Appendix D, subject, Practicability of Boring Bridge and Switch Ties for Spikes Before Treatment. This report will be handled by Mr. Hubley, the Chairman.

Mr. R. S. Hubley (Great Northern):—For several years now a large number of the railroads who have been treating a majority of their cross-ties have been pre-boring the ties for spike holes before treatment, thereby obtaining treated wood around the driven spike and also obtaining a greater amount of the preservative under the rail, where it is mostly needed. The majority of the cross-ties being removed from track today, that were not pre-bored before treatment, will show that the wood had decayed mostly in the vicinity of the spike holes; thereby reducing the holding power of the spike and weakening the track structure. The pre-boring of the track ties for spike holes before treatment is extending the average life of the ties considerably, by preventing early decay in the vicinity of the spike holes, and the increased life that is now being obtained from the pre-bored tie reduced to dollars and cents will many times offset the initial cost of the boring.

In view of the fact that the pre-boring of the cross-ties for spikes was found to be an economical proposition, it was thought advisable that probably bridge and switch ties should also be bored before treatment. However, in the pre-boring of bridge and switch ties due to their various lengths, they could not be bored in the regular tie boring machine but the work would have to be done by hand. This would necessarily increase the cost of the boring considerably.

In order to obtain from the various railroads their opinion on this subject, the following questionnaire was submitted to 34 railroads, to which replies were received from 27.

I will read the questionnaire:

"Q. Are you boring bridge ties for spike holes prior to treatment?

"A. Six roads replied in the affirmative, and 21 No.

"Q. Do you recommend the boring of bridge ties for spike holes prior to treatment?

"A. Seventeen replied 'yes' and 4 'no.' Several thought that it was the proper thing to do if it was practical and could be done economically. One road stated that 'We should do everything we reasonably can that is practical to prolong the life of such material.' Another road did not think it practical account of the different weights of rail used on their line.

"Q. Are you boring switch ties for spike holes prior to treatment?

"A. All the replies were negative.

"Q. Do you recommend the boring of switch ties for spike holes prior to treatment?

"A. Three roads replied in the 'affirmative,' 16 'no,' and the balance had different opinions as follows:

"Most of holes would be different and difficult to keep material in sets, due to the different weights of rail in use.

"Impractical and too costly.

"Difficult to locate the holes properly; probability that turnouts would not be bored to proper line.

"Switch ties would have to be spaced accurately on ground to have the rail conform to the borings.

"Switch ties are not replaced as a rule on account of decay, but are short lived because of the mechanical wear to which they are subjected.

"The penetration received without pre-boring sufficient to preserve the tie until destroyed by mechanical wear.

"Q. If you do not approve of boring spike holes in the entire switch tie, do you think it advisable to bore the switch tie for the main line only (as this is the most used) leaving the turnout side of the track unbored?

"A. Five roads replied in the 'affirmative,' 10 'no,' other replies were as follows:

"Track forces would have difficulty in placing the switch properly in the track according to borings.

"Not economical as switch ties were mostly removed account of mechanical wear.

"Impracticable on account of the tiespacing and switch plates.

"Q. If you approve of boring the main line spike holes in the switch ties, do you think that it would be an economical proposition to bore the switch ties approximately at the location of the turnout rail, in order to obtain a better penetration of the preservative under the rail, no attempt being made to determine the exact location of the spike hole on the turnout side?"

This would merely mean that we would bore four holes in the ties at approximately the location where the turnout rail would come, so that after the tie was treated, the timber in the vicinity of the rail would be thoroughly treated throughout. Then when the rail is spiked, the spikes would be driven into treated wood instead of untreated wood, which would be the case if the ties were not prebored before treatment.

"A. Two roads replied in the 'affirmative,' 15 'no,' others as follows:

"Would not be an economical proposition.

"Believe the main line portion of ties will need renewal from mechanical wear before ties will rot out under turnout rails.

"Do not believe it advisable to undertake to bore switch ties as there are many things which cause enough variation in the condition of the ties to make the holes useless.

"Too many complications in boring switch ties to warrant going into it. The boring will all have to be done by hand, as machines used at the tie treating plants would not take the lengths of timber, and we do not believe the benefit would be worth the extra cost.

"It has been our experience that switch ties removed from track have failed principally on account of mechanical wear, rather than decay, and it is therefore our opinion that the boring of switch ties for spike holes would not warrant the expense entailed."

The Committee concludes: "1. It is the opinion of the Committee that the pre-boring of bridge ties for spike holes prior to treatment is practicable and an economical thing to do.

"2. That the pre-boring of switch ties for spike holes prior to treatment, either for the main line or turnout rails, is to be left to each road to do as they see fit.

"3. It is recommended that the conclusions be accepted and printed in the Manual."

Mr. F. M. Thomson (Missouri–Kansas–Texas):—Conclusion No. 2 is rather an indefinite conclusion, and so indefinitely stated that it contains no beneficial or constructive information. It would not appear that it is proper subject-matter for the Manual. Conclusion No. 3 is really not a conclusion at all, but a recommendation. It occurs to me that only one conclusion in the three is real subject-matter for the Manual—that is Conclusion No. 1.

Vice-President J. V. Neubert:—The Committee accepts the suggestion that 2 and 3 be printed as information. Can the motion be made accordingly?

Mr. R. S. Hubley:—That is correct.

Chairman F. C. Shepherd:—We so move.

Vice-President J. V. Neubert:—Are there any more questions or remarks? All in favor say "aye"; contrary, "no." It is carried.

This Committee is comprised of thirty-five members. This subject has been assigned to this Committee for a number of years. Although a great many may feel that their work is done, it may be true, because I think they have proven very clearly in the past number of years the advisability of the treating and preservation of timber. It is one of the greatest things that we have had in the period we went through last year and possibly this year. Railroads that have been using treated timber for ten or more years have made a saving in the upkeep of the property for maintenance. It is like the woodman in cutting the tree. The tree said, "Treat me with kindness." I do not feel that the Committee wants to be treated kindly, but I feel that you should, in their behalf, consider their recommendations in regard to education, in regard to the application of the use of treated material.

If there is nothing more, the Committee is excused with the thanks of the Association (Applause).

DISCUSSION ON IRON AND STEEL STRUCTURES

(For Report, see pp. 119-134.)

(Vice-President J. V. Neubert in the chair.)

Mr. A. R. Wilson (Pennsylvania):—This is the first report printed in Bulletin 330. The Committee presents report covering the following subjects:

(1) Revision of Manual (Appendix A).

(2) Track anchorage over bridges and similar structures (Appendix B).

(7) Use of copper-bearing steel for structural purposes (Appendix C).

(10) Specifications for punched and reamed work (Appendix C).

(11) Longitudinal forces as they apply to railway bridge superstructures and sub-structures (Appendix E).

(12) Design for rivet heads for steel structures (Appendix F).

The report under Appendix A, appearing on page 120 will be presented by Mr. Simmons, Chairman of the Sub-Committee.

Mr. I. L. Simmons (Chicago, Rock Island & Pacific):—This Committee makes the following report and recommend that it be approved and the revisions substituted for the present recommendations in the Manual:

"That Article 1518, Specifications for Steel Highway Bridges, page 1221, of 1929 Manual, the definition of 'p' be changed to read, 'Allowable unit stress for the column in question.'

"That Specifications for Steel Railway Bridges, appearing in the 1929 Manual be revised as follows:

"Paragraph 8, page 1073, be changed to read:

" 'Structures shall be made wholly of structural steel except where otherwise specified. Rivet steel shall be used for rivets only. Forged steel shall be used for large pins, large expansion rollers and other parts if specified by the engineer. Cast steel preferably shall be used for shoes and bearings. Cast iron may be used only where specifically authorized by the Engineer.'

"Page 1091, Article XI, 'Materials,' be revised to include Specifications for Forged Steel; and that the order of the subjects be as follows: "(a) Structural and Rivet Steel; (b) Forged Steel; (c) Cast Steel; (d) Cast Iron."

The specifications for forged steel are new and it is recommended that they be adopted for printing in the Manual.

Vice-President J. V. Neubert:—It has been moved and seconded. Is there any discussion? Are there any remarks? All those in favor please say "aye"; contrary, "no." It is carried.

Mr. I. L. Simmons:—I should like to move that the changes in Article 1518 and also the change mentioned in Paragraph 8, page 1073 be adopted and printed in the Manual.

Vice-President J. V. Neubert:—Is there any discussion on this? All in favor say "aye"; contrary, "no." It is carried.

Chairman A. R. Wilson:—We recommend that the report on track anchorage over bridges and similar structures (Appendix B) on page 123 be received as information.

Vice-President J. V. Neubert:—Does any person want to make any remark on Appendix B, beginning on page 123?

Chairman A. R. Wilson:—We recommend that the report on the use of copper-bearing steel for structural purposes (Appendix C) on page 126, be received as information.

Vice-President J. V. Neubert:—Is there any discussion or any remarks? If not, proceed.

Chairman A. R. Wilson:—The report on specifications for punched and reamed work (Appendix D) is on page 127. I will ask Mr. Dufour, Chairman of the Sub-Committee, to present this report.

Mr. F. O. Dufour (United Engineers & Constructors):—This subject has been under active consideration by this Committee for eight years. Thousands of tests have been made. Hot and cold riveted specimens of punched and of punched and reamed work, with varying number of thicknesses of material, were made and cut in two through the center and inspected. Tension, bend and hardness tests were made on riveted specimens of punched and of punched and reamed and of drilled work and also of joints.

With the practically unanimous approval of this Committee, which consists of consumers, manufacturers and research engineers, the revision of the entire section of steel bridge specifications on workmanship has been made. The only clause which has been materially changed has been Article 209.

The main difference between the reamed section on workmanship and that now in the Manual is that there is no punched or punched and reamed

work as such. Whether the material is punched, reamed or drilled depends upon the thickness and number of thicknesses of the material, and whether or not it is what we commonly designate as main material.

The revised clauses on workmanship are given in Bulletin 330.

The Committee makes the following report and recommendation (and this report is the section on workmanship) that it be approved and the revision substituted for the present recommendations in the Manual.

Vice-President J. V. Neubert:—Is there any discussion? Are there any remarks? All in favor say "aye"; contrary, "no." It is carried.

Chairman A. R. Wilson:—We recommend that the report on longitudinal forces as they apply to railway superstructures and sub-structures (Appendix E), page 131, be received as information.

Vice-President J. V. Neubert:—Is there any discussion? If not, it will be so accepted.

Chairman A. R. Wilson:—We recommend that the report on design for rivet heads for steel structures (Appendix F) page 133, be received as information.

Vice-President J. V. Neubert:—Is there any discussion? If not, it will be so received.

Chairman A. R. Wilson:—That completes our report.

Vice-President J. V. Neubert:—Are there any questions you would like to ask this Committee? This Committee is comprised of 35 members. They have done very constructive work. In the work that they have done in the past number of years it has simplified not only the design but the practice of steel structures which has been extensively used, and the Committee is excused with the thanks of the Association (Applause).

DISCUSSION ON WOODEN BRIDGES AND TRESTLES

(For Report, see pp. 313-319.)

(Vice-President J. V. Neubert in the chair.)

Mr. H. Austill (Mobile & Ohio):—The report of your Committee on Wooden Bridges and Trestles appears in Bulletin 332. The subjects assigned are listed on page 313 thereof. The Committee has no revisions to propose to the Manual at this time, and if it is agreeable, Mr. Chairman, we will pass on.

Vice-President J. V. Neubert:—Unless any person would like to ask any questions, we will proceed.

Chairman H. Austill:—Subject 2 will be presented by Mr. Hawley, Subject (3) by Mr. Grear, and Subject (4) by Mr. Hart, the respective Sub-Committee Chairmen.

Mr. W. E. Hawley (Duluth, Missabe & Northern):—The subject under Appendix B is Simplification of Grading Rules and Classification of Timber for Railway Uses, collaborating with other organizations dealing with this subject. The report is presented for information. In addition to the information given here, Committee VII is collaborating with a committee on lumber specifications in the Mechanical Division of the American Railway Association for the purpose of seeing if it is possible to so modify the lumber grading rules of this Association that they may be adapted to the use of the Car Division

and both divisions use common grading rules for both timber and lumber. That study is to be carried on during this coming year. This Committee is also asked to appoint advisory members for an investigation on the strength of floor and floor members. The National Lumber Manufacturers Association, in connection with experimental school at the University of Illinois at Urbana, is going to carry on during this year tests of laminated floors and various types of floor constructions in houses and bridges and find out from actual experimental full size panels the stresses and deflections which will develop with different depths and thicknesses of material. This work will offer a good deal of information of value to the Buildings Committee and the Bridge Committee and the members of this Association.

Vice-President J. V. Neubert:—Is there any question? If not, it will be so received.

Mr. S. F. Grear (Illinois Central):—Subject 3, Standardization and Simplification of Store Stock and Disposition of Material Reaching Obsolescence, collaborating with other committees and organizations concerned. This report speaks for itself. It is simply a series of suggestions for the use of obsolete material, for standardization of sizes, and largely represents the experience of members of the Committee on Wooden Bridges and Trestles. It is offered as information.

Vice-President J. V. Neubert:—Are there any questions? If not, it will be so received.

Mr. R. P. Hart (Missouri Pacific):—Appendix D, Overhead Wooden or Combination Wooden and Steel Highway Bridges, Collaborating with Committees VIII—Masonry, and XV—Iron and Steel Structures. The report is too much in detail to be read in its entirety. I wish to call to your attention an error in printing the second estimate on page 317. The third from the last item should be a duplicate of the fourth item in the first estimate; the total for this estimate, however, is correct as printed. I wish also to call to your attention the two typical plans shown on pages 318 and 319 for typical overhead bridges, one having a timber floor and the other having a concrete floor on timber stringers.

Subject (6) has also been taken care of by a change in the assignment for the coming year.

That completes the report of your Committee.

Vice-President J. V. Neubert:—Does anybody wish to ask this Committee any questions?

This Committee was originally called the Committee on Bridges, and as the work expanded, it was split up into two committees. It has been known of late and for a number of years as the Committee on Wooden Bridges and Trestles. They have done very able work, and if I do say it, a great many of them thought we should not have them any more, and the report you have presented this year has very well clarified it to the Association that you are needed now.

The Committee is relieved with the thanks of the Association (Applause).

DISCUSSION ON MAINTENANCE OF WAY WORK EQUIPMENT

(For Report, see pp. 439-481.)

(Vice-President J. V. Neubert in the chair.)

Mr. C. R. Knowles (Illinois Central):—The report of the Special Committee on Maintenance of Way Work Equipment appears on page 439, Bulletin 333. The Committee presents six final reports and four progress reports.

The first report, on Definitions of Terms used in connection with Maintenance of Way work equipment, appears under Appendix A on page 441. One hundred and seventy-five definitions of terms are presented. It is moved that these definitions be accepted for publication in the Manual.

Mr. Fritch just handed me a letter here with some exceptions to the definitions as submitted. It is not permitted to discuss definitions on the floor of the convention, but the Committee will be glad to accept any suggestions or criticisms of the definitions as presented. In recommending them for inclusion in the Manual, it should be understood that they are subject to such changes or criticism as may be presented by members of the Association. Such criticisms or suggested changes in the definitions are invited.

Vice-President J. V. Neubert:—All in favor say "aye." Contrary, "no." It is carried.

Chairman C. R. Knowles:—The next report, on Standardization of Parts and Accessories for Railway Maintenance Motor Cars, appears on page 451. Mr. Westcott is Chairman of the Sub-Committee and will present the report.

Mr. G. R. Westcott (Missouri Pacific):—The subject of Standardization of Parts and Accessories for Motor Cars was first studied by a Sub-Committee under Committee XXII—Economics of Railway Labor. This, I believe, was in 1926. No very definite results were secured until last year when the Sub-Committee having it in hand recommended to the convention some sketches indicating their recommendations as to standards in the matter of wheels and axles. This year the work was transferred from the Committee on Economics of Railway Labor to the Special Committee on Maintenance of Way Work Equipment, and the work this year was restricted mainly to a study of couplers, safety rails and tool trays.

On pages 452 and 453 of Bulletin 333 will be found the recommendations of the Sub-Committee, which we are submitting to you for publication in the Manual, if satisfactory.

Mr. Louis Yager (Northern Pacific):—Some of us have been wondering what this is all about. We notice that there was a shortage of ink or something in this sketch. Was that intentional or otherwise?

On page 453, we do not know whether that sketch represents a tray or a handbasket.

Mr. G. R. Westcott:—I would say that the difficulty perhaps was somewhere between the Committee and the printer. It was not desired to put any title on the drawing. It should have been published, however, with a title under the drawing. The Committee will be very glad to have that arranged before it is placed in the Manual, if there is no other objection.

Vice-President J. V. Neubert:—Are there any other discussions? All in favor of this motion, please say "aye." Contrary, "no." It is so ordered. Proceed, Mr. Knowles.

Chairman C. R. Knowles:—The next report, on Methods of Alarm for Gasoline Propelled Track Cars, appears under Appendix C, page 451. Mr. Ordas, Chairman of that Sub-Committee, will present the report.

Mr. C. H. Ordas (Chicago, Milwaukee, St. Paul & Pacific):—The Committee investigated the merits of the various types of warning signals, also the legal requirements in the several states and various municipalities, and submit the report as shown on page 451, Bulletin 333. The conclusions of the Committee are:

"(1) The use of warning devices on track cars is not recommended except under special conditions.

"(2) Where desirable or advisable to use a warning device, the mouth blown whistle of the type used by police officers furnishes the most efficient alarm for use on track cars."

Chairman C. R. Knowles:—It is moved that the report be received as information and the subject be discontinued.

Vice-President J. V. Neubert:—Is there any discussion on this? I am very glad that they have decided to do that, under Item No. 2. That seems to be the experience of quite a number.

Unless there is objection, it is so ordered. Proceed, please.

Chairman C. R. Knowles:—The next report is on Methods of Scheduling and Assigning of Work Equipment, giving particular attention to equipment used in seasonal work, appears under Appendix D on page 455. Mr. Mabile is Chairman of the Sub-Committee, and I shall ask him to present the report.

Mr. J. B. Mabile (Chicago, Rock Island & Pacific):—Your Committee takes the liberty to view and report on this subject from a standpoint of scheduling work instead of scheduling and assigning machines, the thought being, in order to keep machines at work the greatest number of days possible throughout the year, that the scheduling of non-seasonal work was really the most important. The seasonal work has to be done, or should be done in its turn. The fact that we have kept the various machines in service and kept them in repair and used them means that we have decided that they are labor-savers. The next thought is, is the machine a money-saver? There is quite a difference, your Committee feels, between the two.

From those thoughts we have drawn the following conclusions:

"(1) Each machine must be operated a definite number of days before it becomes a profitable investment.

"(2) Seasonal work should be programmed and machines so assigned as to reduce to a minimum the work done by hand or other methods.

"(3) Non-seasonal work should be scheduled in order to utilize all machines the greatest possible number of days throughout the year. The adaptability of the various machines for this class of work must be carefully considered."

In addition to those conclusions, we have presented as information Exhibits A and B, showing data on the various machines where we could get definite information, which we feel will be of value to anyone studying the use of machines from this standpoint.

Chairman C. R. Knowles:—It is moved that the report be received as information and the subject continued.

Vice-President J. V. Neubert:—Is there any question? If not, it will be so received.

Chairman C. R. Knowles:—The next report appears on page 458, "Methods of Keeping Data on Work Equipment and Labor-Saving Devices," under Appendix E. Mr. Constance is Chairman of the Sub-Committee and will present the report.

Mr. Walter Constance (Chesapeake & Ohio):—This subject was handled very ably last year by a Sub-Committee of Committee XXII. They submitted a large number of forms, and we were rather at a loss to know what to dó in presenting something further. I will read the conclusions we came to:

"Your Committee wishes to emphasize the statement of Sub-Committee 10 in its report, that the 'major objective of keeping data on the performance of labor-saving devices is to determine whether economy may be effected through their use when compared with other methods of doing work.'

"It is also our opinion that the data obtained should develop information as to the efficiency with which the device is being handled and if it is being properly maintained.

"Your Committee submits herewith various forms of performance reports as information for your consideration, believing that the exhibits serve only as examples of existing practice," (I may say that these are copies that I secured from different railroads and are actually in service) "and that the character of the forms required on any particular railway is subject to the nature of the information desired by the officers in charge.

"Exhibit A—Report for ditchers and drag lines.

"Exhibit B—Report for mechanical tie tampers, provides for complete daily report from foremen, it also has an extension to be filled in by Cost Engineer or Supervisor. It includes hand tamping done in connection with machine work together with other information necessary in full analysis of the job.

"Exhibit C—Report of ballast cleaner, with extension for completing the data.

"Exhibit D—Report on power rail laying machine.

"Exhibit E—Report showing performance of mowing machine.

"Exhibit F—Report on spreader ditcher.

"Your Committee has made special inquiry as to reports on motor car performance and has received and considered a number of good forms. However, the forms in the Manual, as shown on pages 1468 and 1469, seem to meet the requirements as well as any.

"Conclusion: Maintenance officers should continue to give careful consideration to the keeping of cost data, not only as to the comparative economy of machine and hand labor, but also for the purpose of developing the relative merits of different machines in the same class. We are of the further opinion that such records, properly kept, will be of benefit in securing the maintenance of equipment and in assuring its proper maintenance."

I may say we had a couple of forms last year that we thought ought to be included in the Manual. After talking the matter over with the Committee on Accounts, they decided they were not exactly as they should be and could not be used for accounting, so probably we will have something that will meet with their approval to offer the next time we report.

Chairman C. R. Knowles:—This report is presented as information. I move that it be so received and the subject continued.

Vice-President J. V. Neubert:—Are there any questions to be asked on this report? If not, it will be so accepted.

Chairman C. R. Knowles:—The next report on Organization for Use and Maintenance of Tie Tamping Machines appears on page 465, under Appendix F. Mr. Holt, Chairman of the Sub-Committee, will present the report.

Mr. L. B. Holt (New York Central):—Your Committee has prepared a concise report supplemented by tables and diagrams of what appear to be the best tie tamping practices under general conditions, and suggest in their application that each railroad make such modifications as their special requirements justify.

We have tried to adhere to fundamentals, avoiding commonplace and well-known details.

Supplemental data will be added in later reports as the need appears, and we solicit suggestions to this end.

Vice-President J. V. Neubert:—Is that a progress report? Is there any discussion? If there is no objection, it will be so received.

Chairman C. R. Knowles:—The next report, Care of Work Equipment when not in use, with particular reference to proper housing, appears on page 469 under Appendix G. Mr. Pharand, Chairman of the Sub-Committee, will present the report.

Mr. E. Pharand (Canadian National):—The Committee went into this to quite an extent. I will just read the conclusions on this:

"(1) It is essential to drain boilers, water reservoirs and tanks on equipment when not in use. Plugged openings should be installed in the equipment for this purpose, and the holes properly rodded when plugs are withdrawn to assure complete drainage.

"(2) The use of oils, greases and anti-corrosive preparations is urged in view of the great saving effected in the prevention of rust and corrosion by this protection when equipment is in storage.

"(3) The assignment of track space or sheds for heavy equipment is strongly urged in view of the saving that may be effected by not having the equipment unnecessarily switched."

Chairman C. R. Knowles:—This report is presented as information.

Vice-President J. V. Neubert:—If there is no objection, and no discussion, it will be so received.

Chairman C. R. Knowles:—The next report is on Standard Colors for Work Equipment and Motor Cars, which appears on page 470 under Appendix H. Mr. Hewes, Chairman of the Sub-Committee, will present the report.

Mr. F. S. Hewes (Atchison, Topeka & Santa Fe):—In addition to the canvass of railway officials and equipment manufacturers, as shown on pages 470 and 471, this subject was also handled with the Safety Section of the American Railway Association.

They consider that yellow for motor cars and light work equipment would be the best for the purpose, and that black for heavy work equipment would be suitable. The report of this Sub-Committee agrees with the majority of the replies received from the various railroad officials.

As the result of our study, the Committee offers the following conclusions for the predominating colors:

"The most suitable colors for use on motor cars and work equipment are as follows:

For motor cars......................Yellow (medium chrome)
For light work equipment...........Yellow (medium chrome)
For heavy work equipment...........Black

"The Committee recommends the adoption of the conclusions for publication in the Manual and that the subject be discontinued."

Vice-President J. V. Neubert:—Does anyone want to offer any discussion, particularly on tie tampers?

Mr. A. F. Blaess (Illinois Central):—It does not seem desirable to adopt for printing in the Manual standard colors for motor cars. All railroads have their own standards for painting motor cars, and I do not see any reason for adopting a standard color for painting motor cars applicable to all roads. They do not have standard colors for painting their passenger or freight cars.

Mr. F. S. Hewes:—This subject was assigned to this Committee and we tried to carry out the wishes of the Association.

Vice-President J. V. Neubert:—You still wish to stick to your recommendation?

(The motion was put to a vote and carried.)

Chairman C. R. Knowles:—The next report is on Standardization of Voltage and Kind of Current for Use in Electrically Operated Machines and Tools for Roadway Purposes, on page 472, under Appendix I. Mr. Henderson is Chairman of the Sub-Committee and I will ask him to deliver the report.

Mr. P. R. Henderson (Illinois Central):—This was originally assigned to Committee XXII who presented a report in March, 1930. The report was referred back to Committee XXII and re-assigned to this Committee by the Board of Direction.

The former Committee reporting on this subject gave the matter a great deal of study, and the report contained the views of both manufacturers and users. In addition to this, the Committee has the benefit of Committee XVIII on Electricity.

We have arrived at the following conclusions on this matter:

"(1) Electric current generated by commercial and privately owned power plants varies widely, ranging from 115 volts to 220 volts, 3-phase, both 25 and 60-cycle, while direct current ranges from 32 volts as used on passenger equipment to 650 volts direct current.

"(2) Manufacturers of electrically driven roadway machines and tools are in favor of standardization of current characteristics except in tools of the vibrating or impulse type and electric welding.

"(3) The voltage most commonly available commercially is 115-volt, 60-cycle, single phase alternating current as used on lighting circuits, and 220-volt, 3-phase, 60-cycle current as most commonly used on power circuits.

"(4) That 115-volt, single phase, 60-cycle alternating current is recommended for roadway tools and machines, 2 H.P. and less, and that 220-volt, 60-cycle, 3-phase alternating current is recommended for machines requiring more than 2 H.P."

Chairman C. R. Knowles:—This report is presented as information with the recommendation that the subject be discontinued.

Vice-President J. V. Neubert:—Are there any questions? If not, it will be so received.

Chairman C. R. Knowles:—The next report is on Best Practice of Maintaining Labor-Saving Devices on Construction and Maintenance of Way Work, and the organization of the necessary supervisory force, which appears on page 475, under Appendix J. Mr. Howe, who is Chairman of the Sub-Committee, is asked to deliver the report.

Mr. C. H. R. Howe (Chesapeake & Ohio):—This subject also is one that was originally assigned to Committee XXII, presented to the convention last March, and referred back to the Committee. Subsequently it has been referred to this Committee.

The chief objection to the report as submitted in 1930 was based on the recommendation of the Committee that maintenance of way work equipment not covered by M.C.B. rules should be concentrated in shops entirely independent of the Mechanical Department and under an organization controlled by the Maintenance of Way Department.

The report now given follows the same general lines as the one submitted by the former Committee, but the recommendation as to the operation of the shop is modified to conform to the views of the 1930 convention. The point in question is covered by Conclusion 3 on page 478 now reading as follows:

"(3) Where there is sufficient work to justify it is preferable that the maintenance of equipment not covered by M.C.B. rules should be concentrated in shops controlled by the department that is responsible for the operation of the equipment."

Conclusions 1, 2, 4, and 5 are virtually the same as were submitted last year except that the numerical order has been somewhat changed, and also the meaning has been clarified.

"(1) In order to avoid interruption to working schedules and to lengthen the intervals between shop overhaulings, particular attention should be given to running repairs and field maintenance.

"(2) An adequate supervisory force should be employed to insure proper maintenance of work equipment, both in field and shops."

The third we have already read.

"(4) Careful consideration should be given to the location of these shops to avoid excessive haul of equipment. Where plants already exist consideration should be given to the possibility of utilizing these facilities.

"(5) These shops should be properly arranged for the work to be done and equipped with all necessary tools and machinery."

Chairman C. R. Knowles:—This report is submitted as information.

Vice-President J. V. Neubert:—Are there any remarks or discussion on this report? If not, it will be so received.

Before this Committee is excused, this is the first year that this Committee has been in force, and this subject has been before the Board of Direction for several years prior to its installation. We felt that we should throw the work now assigned to this Committee into other committees, and we are now glad that we have not. It is their first year's report, and they are now freshmen. I was wondering in my own mind what kind of a report they would give when sophomores, because in a body of thirty-seven men, some of them may be timid, but I know when they work to full boiler pressure they are going to give us some very valuable information, not only in regard to the application and upkeep, but also the desirability and what kind of equipment should be purchased.

I assure you, gentlemen, that this Committee is excused with the thanks of the Association (Applause).

Mr. E. E. R. Tratman (Engineering News–Record) by letter:—As the definitions include "Scraper" and "Spreader," they might logically include "Bulldozer" and "Track Shifter." As to "Ditcher," it seems preferable to omit "Jordan," but include: "Ditcher, power-shovel type" and "Ditcher, plow type."

Bulldozer—A blade or plow attached to a pole and pushed by horses, or to the front end of a tractor or motor truck. Used to level material dumped for filling low ground or widening banks.

Track Shifter—A power-operated track-car equipped with apparatus to shift track laterally or to raise it vertically for ballasting.

DISCUSSION ON YARDS AND TERMINALS

(For Report, see pp. 207-220.)

Mr. H. L. Ripley (New York, New Haven & Hartford):—The report of the Committee on Yards and Terminals will be found in Bulletin 331, the first report in the Bulletin, on page 207.

The first subject, Revision of the Manual, Appendix A, with the permission of the Chairman, will be passed for the moment.

The next subject upon which the Committee is to report, is Coach Yards. Mr. H. J. Pfeifer, Chairman of the Sub-Committee, is not present. The work of this Sub-Committee for the year has been principally one of collaboration with another joint committee representing railway sanitation, United States Public Health Service, and the American Railway Association. This Committee is expected to get out a Manual having to do with the matter of public health in the near future and the Committee on Yards and Terminals having this matter in hand have been of such assistance to them as they could be in preparation for that work. The report is one of progress and for information only.

The President:—Are there any questions to be asked concerning that, or any discussion of the subject? If not, it will be so received.

Chairman H. L. Ripley:—The third subject given to your Committee was effect of motor coach service on design and operation of way and terminal station facilities.

The Committee has no formal report to make. It has collected information and reports progress on this assignment. Mr. Bassett, Chairman of that Sub-Committee, is not present.

Again, the report is merely for information. We expect by next year to have something definite to offer to the Association.

The President:—This report is submitted as information, but I am sure the Committee would like to have some discussion, if any one feels so inclined.

Chairman H. L. Ripley:—Gentlemen, this is a very live subject at the present time among some carriers. Mr. Bassett would be very glad to receive any information or any suggestions that members of the Association can give him, particularly in connection with statistics or plans or anything of that nature that may have been worked up by representatives of the different railroads. It would be helpful to the Committee. They have very little to go on at the present time.

The fourth subject, provision for parking and garage facilities for private automobiles of railway passengers at passenger terminals and way stations, appears as Appendix C on page 209. Mr. Beugler unfortunately was not able to be present but he sent a written report. As it is short I will read it because it will say what he would like to say much better than I could do otherwise.

"The Sub-Committee has continued work along the same general lines as last year. A letter was sent to each of a representative list of railway officials, and this year's progress report in Bulletin 331, page 207, is based on the replies received.

"The subject of provisions for parking private autos of railway patrons at passenger stations is in the try-out stage and time will be required to determine how far the railways are justified in providing facilities at various locations. In connection with this situation, the Committee has suggested for next year's work the consideration of parking space provided jointly by the railway company and the municipality or some other public body. A few such cooperative examples have been reported, which indicate satisfaction to all parties concerned. The Committee has also suggested for next year a study of designs for parking space, designs having regard to the best arrangement for maximum capacity on a given area with reasonable spacing of cars, and incidental to this, the provision of separate entrances and exits to facilitate safe and convenient movements.

"The President of a large Western railway system is quoted as saying that:

"'Working with the motor car owner doubtlessly has helped our business. At all of our stations, except one or two in the largest cities, we provide free parking space for motorists. It is to our advantage to have them come to the stations, find parking space readily and board our trains. That certainly is better than having them put to great disadvantage in parking, or failing to find space at all.'

"The Committee will welcome any information relative to this subject from members at large who have been confronted with the problem, and their experiences as to what benefits, if any, have been secured to the railway company."

This report also is presented for information only.

The President:—This is a very interesting subject, gentlemen, one of quite a good deal of importance as having a possible bearing upon the loss of passenger business or the regaining of some of the business lost to the motor vehicle.

If there is no discussion it will be received as information.

Chairman H. L. Ripley:—The fifth subject assigned to the Committee is Effect of Motor Coach Service on Design and Operation of Way and Terminal Station Facilities. Mr. Lyford is the Chairman of that Sub-Committee.

The General Committee considered this more in the nature of a stand-by subject to watch proceedings than anything that could be reported upon definitely today. Mr. Lyford, have you anything to offer?

Mr. L. L. Lyford (Illinois Central):—As the Chairman has stated, this is an assignment that has been before the Committee for the past two or three years.

Two years ago, and again last year, a report was made discussing some phases of this question and showing developments to date. Changes in connection with the use of motor trucks are slow in developing, and the Committee this year did not have sufficient data to find it worth while to submit a report. It has collected some data and considered some phases of this subject, such as the construction of produce terminals, which is more or less a recent development along this line. It has had difficulty in collecting up-to-date information on this subject, and I am sure the Committee would welcome anything that any of the members can give this coming year that might be helpful in adding information to what we now have for a report this coming year.

We are simply standing by as a Committee watching the situation, ready to report anything that is of value when it develops.

Chairman H. L. Ripley:—This report, also, is merely for information.

Subject 6, Hump Yards, Appendix D. This has been the main work of the Committee for the past year. The report will be found beginning on page 210 of Bulletin 331. Mr. R. J. Hammond, Chairman of the Committee, is not present, and Mr. G. F. Hand, who worked closely with him, is unfortunately ill.

The report is not in shape yet to present as Manual material. The subject is a very elusive one, as one can very well understand, particularly where retarders are used, when you consider that the rolling resistance of the car varies from about five pounds for one car up to twenty-eight pounds for another and must be handled over the same hump and through the same retarders.

The Committee has found it exceedingly difficult to turn the recommendations into concrete figures upon which they feel they can stand. Many experiments have been made and much research work has been done. Mr. Rudd has been connected with this work intimately, and Mr. Rudd will tell you better than I can about that interesting detail.

Mr. W. B. Rudd (Union Switch & Signal Company):—What we tried to do this year was to get a method for determining gradients in such shape that it could be presented to the convention, and that we would at least get the reaction of the membership as a whole, not only at the convention, but in the succeeding months, as to this method.

The report also gives certain figures experimentally, you might say. It is the idea, provided the method is agreed upon, to try to analyze information at hand and such information as is later obtained, in order to give more definite figures. The main thing on the method is found at the bottom of page 211, and I am just going to read a couple of sentences from that, because if the membership at large does not agree with the Committee on the method, it very vitally affects our work for the coming year as well as what we have already done.

"In determining the proper gradients, there are two basic conditions to be met:

"(1) The heavy easy rolling car under the most favorable running conditions (hot weather, following wind, etc.).

"(2) The light hard rolling car under the least favorable running conditions (cold weather, adverse winds, etc.).

"Sufficient difference in elevation, or drop, must be provided from the crest of the hump to the clearance point of any classification track, so that the hard rolling car under adverse conditions will roll into clear on its classification track.

"It is fundamental, however, that cars do not accelerate unduly after leaving the last retarder, if damaging impacts are to be avoided, thus the gradients that should be provided below the last retarder must be such as will result in very little, if any, acceleration of the easy rolling car under favorable conditions.

"Thus the drop from the crest of the hump to the end of the last retarder should be 'A' minus 'B.'

" 'A' is the amount of drop required between the crest of the hump and clearance to insure the hard rolling car under adverse conditions not stopping short of clearance.

"'B' is the drop required from the end of the last retarder to clearance to insure that the easy rolling car under favorable conditions does not unduly accelerate."

As far as gradients is concerned, that is the crux of the whole situation. The other features reported on can be much more easily determined. The gradients are the difficult feature.

I know that the Committee will welcome any suggestions or comments or criticisms as to this report, with particular attention to the method that we have tried to develop and present as information this year.

Chairman H. L. Ripley:—Assignment 7, Coordination of facilities at rail and water terminals. This Committee is unfortunate this evening in that while it has quite a good many members present, the Sub-Committee chairmen are conspicuous by their absence. Mr. Smith, Chairman of that Sub-Committee, is not present. I know he has collected a substantial amount of information and is looking for more.

Subject 8, Design of airports in connection with railway yards. Mr. Hood, of the Akron, Canton & Youngstown Railway, was Chairman of that Committee. He was obliged to resign in the middle of the year, and Mr. Anderson of the Santa Fe very kindly took over the assignment, with the stipulation that he be not required to make a report this year. He hopes and expects to have something to present to the Association at its next meeting.

Subject 9, Scales Used in Railway Service. Mr. Harrison, Chairman of that Sub-Committee, will make that report. This is the reason that I asked to have Subject 1, Revision of the Manual, passed for the time being. Mr. Harrison will handle both subjects.

Mr. M. J. J. Harrison (Pennsylvania):—The report of the Committee covering Scales is found on page 214 of Bulletin 331. This page outlines very briefly a very considerable amount of work done by the Committee during the past year, as a result of which the Committee concluded that certain portions of the present Manual material were unsatisfactory. It would have been possible to introduce detailed evidence in the report but it would then have been unnecessarily bulky, and it was understood that was what the Board of Direction wanted to avoid. The evidence was all of a negative character. In other words, it all tended to show that the existing Manual material was, as a matter of fact, not satisfactory for the reasons stated on page 219 of the Bulletin.

For that reason your Committee recommends the adoption of the conclusion stated at the bottom of page 214, to the effect "that the portion of the Manual on pages 1031 and 1032, under the heading 'V—General Specifications for Master Scales,' be deleted."

This motion is made with the expectation that, if it prevails, the Committee will undertake to prepare something more acceptable. In the meantime, it is felt that it would be better to have a formal record of the deletion of this material, even though, as a matter of fact, it will not be erased, but there will be a warning flag up to whoever might seek to use such material. What is now in the Manual, as a matter of fact, is not satisfactory.

On behalf of the Committee, I move adoption of the conclusion just stated.

The President:—You have heard the motion, gentlemen. Is there any discussion? I take it that the deletion of this material is largely because it has grown out of date.

Mr. M. J. J. Harrison:—On the contrary, the deletion of the material is recommended at this time because of the advance that has been made in the art, if you please. It is felt by the Committee that we know more about the subject now than was known at the time the present Manual material was written, and for that reason it is believed that the Committee is in a position to prepare something that would be acceptable, and that the material which now exists, being unsatisfactory, should be deleted.

The President:—Is there any discussion on the motion? If not, those in favor will please say Aye. Contrary, No. It is carried.

Mr. M. J. J. Harrison:—The balance of the report is submitted as information, Mr. President.

The President:—It will be so accepted.

Chairman H. L. Ripley:—The Committee wants to express its appreciation and thanks to Mr. E. E. R. Tratman and to Professor Sadler for the very complete bibliography in connection with Railway Stations, Yards, Marine Terminals and Airports; in other words, in connection with the work of the Yards and Terminals Committee.

This concludes the report of the Yards and Terminals Committee for the year.

The President:—This Committee has done excellent work this year and I should like to here express the view that a committee's work cannot for any given year be measured by the amount of material submitted for adoption in the Manual, nor even by the volume of matter appearing in the Bulletin, in the reports. Much work can be done preparatory to reports in succeeding years with definite recommendations which can be accepted. The Committee is excused with the thanks of the Association (Applause).

DISCUSSION ON SHOPS AND LOCOMOTIVE TERMINALS

(For Report, see pp. 483-500.)

Mr. L. P. Kimball (Baltimore & Ohio):—The report of the Shops and Locomotive Terminals Committee is found in Bulletin 333, pages 483 to 500 inclusive.

The Committee this year reports on three of the seven subjects assigned. Considerable work preparatory to submitting a definite report at some later date has been concluded on the other subjects, but they are not in shape to be presented at this time.

The first report presented is that in Appendix A, Locomotive Washing Platforms. That report will be presented by Mr. McBride, Chairman of that Sub-Committee.

Mr. J. S. McBride (Chicago & Eastern Illinois):—The report of the Sub-Committee appears as Appendix A at page 484.

A questionnaire, relative to various features of washing platforms, was sent to twenty-six representative railroads and twenty-two replies were received. The replies of roads using washing platforms are tabulated in and

shown as Exhibit A, which appears immediately following page 500. The replies received show various types of platforms in use. Plans of some of the different types of permanent platforms that have been installed have been reproduced for information and are shown on pages 486 to 490.

The conclusions of the Committee which we are recommending for inclusion in the Manual start on page 485. I shall read the heading of each section of the conclusions: Type, Size, Location, Drainage, Lighting, Housing Washing Machines, Oil Storage.

I move the adoption of these conclusions for insertion in the Manual.

The President:—Do the plans on page 486 and 487 go with these?

Mr. J. S. McBride:—No, sir; they are submitted for information only.

The President:—The motion is that the conclusions on pages 485 and the top of page 486 be approved for publication in the Manual. Is there any discussion?

This is somewhat new subject-matter, I believe, but a good many railroads are using washing platforms quite extensively.

If there is no discussion, I will put the question.

(The motion was put to a vote and carried.)

Chairman L. P. Kimball:—The next subject, General Layouts and Design of Car Shops, will be handled by Mr. Metcalf, Chairman of that Sub-Committee.

Mr. J. M. Metcalf (Missouri–Kansas–Texas Lines):—The Committee submits as information the report on General Layouts and Design of Car Shops, which appears on pages 491 to 498 inclusive in Bulletin 333.

This is a continuation of studies of car shops previously reported in 1921 and 1925, and outlines briefly the work done by the Mechanical Division on this subject and recent developments in car shop design, including some typical plans of such shops constructed during the last few years.

Attention is called, also, to the hazard resulting from the use of inflammable lacquers and finishes in painting cars, especially where applied by the spraying process. Reference is made to publications which contain information as to the best practice in the design and operation of paint shops to safeguard against fire.

Chairman L. P. Kimball:—This subject is submitted as information only. As the Sub-Committee Chairman has said, it is an extension of the work previously assigned to the Committee. The Committee finds that the subject-matter on the previous report as included in the Manual still holds good as its recommendation today. It is offered merely as information at this time.

The President:—Is there any discussion of this information on car shops? If not, it will be received as information.

Chairman L. P. Kimball:—The next subject reported is Inspection Pits. This report will be presented by Mr. Lorenz, Chairman of that Sub-Committee.

Mr. H. C. Lorenz (Cleveland, Cincinnati, Chicago & St. Louis):—This report appears in Appendix C, Bulletin 333. The Committee felt it should confine itself to a general description of locomotive inspection pits and general discussion of design and operation. It is the recommendation of the Committee that inspection pits should be reinforced concrete, well-drained, electrically lighted in such a manner as to avoid too much glare and too strong shadows, that the pit be located beyond the coal dock so as to permit sufficient time to elapse between inspection and arrival of locomotive at the engine

house in order that necessary material may be assembled and prepared to be proceeded with upon arrival of the locomotive in the house. The Committee is not disposed to make recommendation concerning size of pit, shelter or means of communication with points outside the pit as these are questions which must be determined by local conditions.

The President:—That is offered as information.

Chairman L. P. Kimball:—The report of the Sub-Committee is offered as information, I might say, largely for the reason that the Committee found in their study of the subject of inspection pits that the use of inspection pits by the various railroads was by no means general; that there were a few railroads using them, many were not, and the information presented represents the practice of those who did find them convenient, but the general use was not sufficient, in the Committee's judgment, to justify making a definite recommendation for Manual material.

The President:—Is there any discussion on this subject?

Mr. S. E. Shoup (Kansas City Southern):—On this subject which is one on which I have endeavored at length to find some authority, it would seem fitting that the Committee for next year be assigned not what I should say is a typical engine layout but an ideal one, one to which we could work adapting the conditions that would have to be met, the special conditions, to that ideal. I earnestly recommend that the Committee be given such an assignment for next year.

Chairman L. P. Kimball:—May I ask Mr. Shoup a question? I did not quite understand him. Did you refer to a general layout or to the particular details of an inspection pit?

Mr. S. E. Shoup:—Mr. Chairman, I meant a general layout, not of the inspection pit alone but the whole thing.

Chairman L. P. Kimball:—Of course, the subject handled here was merely in regard to the details of inspection pits where they might be used. The files of the Association (I am not sure whether it was Manual material or not) do include a report by this Committee of a typical or ideal layout of an engine terminal several years ago.

Mr. S. E. Shoup:—I admit that, and I have come across that in my investigations, but it isn't up to date. It differs in so many details from what we are doing at the present time that it seems to me it should be revised and brought up to date. As for inspection pits in general, we have built several, no two of which are identical from either the standpoint of construction or location. I think that the whole subject is one that lends itself well to an ideal treatment and with the adaptation necessary to meet the local conditions.

Mr. W. P. Wiltsee (Norfolk & Western):—I should like to add a word to what Mr. Shoup has said. I think an engine terminal that has no inspection pit today is certainly way behind time. There are certainly enough used in this country at the present time to justify a design for our Manual. There are a good many points in connection with an inspection pit that require considerable study, and I hope the Committee will continue the subject and give us a recommendation next year.

The President:—The Committee on Assignment of Work will please take note of that discussion. Is there any further discussion? If not, this Appendix C will be accepted as information. This completes the report of this Committee, and it is relieved with the thanks of the Association (Applause).

DISCUSSION ON BUILDINGS

(For Report, see pp. 547-605.)

Mr. A. L. Sparks (Missouri-Kansas-Texas):—The report of Committee VI, Buildings, is found in Bulletin 334 beginning with page 547. Subject No. (1), Revision of Manual, is shown in Appendix A. In it the Committee recommends first the changes in the specified width for freight houses now given on page 268 of the 1929 edition of the Manual, the proposed form for which reads as follows: "Where hand trucks are to be used for trucking freight, the outbound house should be not more than 30 feet wide and the inbound house should be from 40 to 60 feet wide.

"Where tractors and trailers are to be used for handling freight, the width of the outbound house should be from 50 to 60 feet wide and preferably free of columns."

Second, the Committee recommends that the second paragraph of the specifications for roofing given in Specifications for Buildings on page 320 of the 1929 edition of the Manual be changed to read as follows:

"Tarred felts shall be composed of rag roofing felt impregnated with a coal tar saturant, and shall weigh not less than 14 lb. per 108 square feet.

"Asphalt felts shall be composed of rag roofing felt impregnated with an asphaltic saturant and shall weigh not less than 14 lb. net per 108 square feet for light weight felts or 30 lb. net per 108 square feet for heavy weight felts as hereinafter specified.

"Asbestos felts shall be composed of genuine long fiber mineral asbestos impregnated with an asphaltic saturant and shall weigh not less than 14 lb. net per 108 square feet for light weight felts or 60 lb. for heavy weight felts as hereinafter specified.

"Felts may be furnished in widths of 32 or 36 inches. They shall be uniform in appearance, free from visible external defects, pliable, and shall not stick to such an extent as to cause tearing when unrolled."

This new proposed form is to specify asphalt felts as well as rag felts and to distinguish between the lighter and the heavier grades.

The President:—You have heard the motion, gentlemen. Is there any discussion? If not, those in favor of the question will please say "aye"; contrary, "no." It is carried.

Chairman A. L. Sparks:—Subject (2), Specifications for Concrete Used in Railway Buildings, Collaborating with Committee VIII, Masonry, is shown in Appendix B and will be reported by Mr. A. C. Irwin.

Mr. A. C. Irwin (Portland Cement Association):—The specifications for concrete used in railway buildings conform largely to the specifications prepared by the Committee on Masonry and adopted previously. There are, however, certain differences that the Committee on Buildings considers important. The specifications are presented at the present time merely as information, with the idea that the membership will give them a careful and critical reading and give the Committee on Buildings the benefit of that critical reading. It is especially requested that the membership review these specifications with the idea that they are to pertain to the construction of railway buildings. The Committee, if so instructed, will prepare specifications for

concrete used in railway buildings and present them next year for adoption and printing in the Manual.

The President:—These specifications are submitted as information. Is there any discussion at this time? I am sure the Committee would welcome it.

Chairman A. L. Sparks:—Subject (3), Preparation of Specifications for Buildings for Railway Purposes, is shown in Appendix C, and will be reported by Mr. F. R. Judd, Chairman of that Sub-Committee.

Mr. F. R. Judd (Illinois Central):—Appendix C, reporting Subject 3, is found on pages 556 and 557 of Bulletin 334. The Committee offers for publication in the Manual certain specifications which were offered as information and published in the Proceedings last year. These are known as Section 19-F, Oil Burning Equipment; Section 24-A, Sheet Asphalt Pavements. These specifications have now been in existence for a year and it is therefore the recommendation of the Committee that they be accepted for publication in the Manual. It is so moved.

The President:—The question is the adoption for publication in the Manual of the specifications as described in the second from the last paragraph on page 556. These were published in last year's Proceedings and are now offered for approval for the Manual.

I recognize that it is practically impossible to offer discussion on these specifications at this time unless you should have a copy of them with you. The Association, however, has had the specifications before it for a year, and it seems quite certain that if any defects in the specifications had developed they would have been reported to the Committee by this time. Is there any discussion on the subject?

(The motion was put to a vote and carried.)

Mr. F. R. Judd:—The Committee also recommends for publication in the Manual Section 24-B, Asphalt Mastic Floors, with one revision, this revision being found at the top of page 557 of Bulletin 334. The revision reads as follows and covers Article 4 of the original specifications: "The mastic slabs shall be made from asphaltic cement and well graded, specially prepared mineral aggregate, both as specified hereinafter. The asphaltic cement and the aggregate shall be mixed in such proportions that the resulting mastic slab shall contain, by weight, from 12 per cent to 18 per cent bitumen. The mastic slab shall be delivered to the site of the work in convenient sizes for easy handling."

The Committee recommends the adoption of specification 24-B, Asphalt Mastic Floors, with this revision just read. I so move.

The President:—It is moved and seconded that specification 24-B for Asphalt Mastic Floors, appearing in Bulletin 334, with the revision now suggested by the Committee, be adopted for publication in the Manual. Is there any discussion?

(The motion was put to a vote and carried.)

Mr. F. R. Judd:—The rest of the report of this Committee refers to certain specifications which were published last year and which are held in abeyance for further study, and also calls attention to the fact that other specifications are in the course of preparation and will be presented next year.

Chairman A. L. Sparks:—Subject (4), Waterproofing and Dampproofing as Applied to Existing Buildings, Collaborating with Committee VIII—

Masonry, is shown in Appendix D. Considerable work has been done on this subject by this Committee, but the subject has been withdrawn and assigned to a Special Committee on Waterproofing, consisting of members of Committee VI, Committee VIII and Committee XV, so this Committee does not submit a report thereon at this time.

Subject (5), Various Types of Trainsheds and Factors Controlling their Selections, is shown in Appendix E.

The Committee recommends that this be accepted as a progress report and referred back to the Committee for further study.

The President:—It will be so accepted.

Chairman A. L. Sparks:—Subject (6), Freight House Doors is shown in Appendix F.

The Committee also recommends that the report on this subject be received as progress, and that it be referred back to the Committee for further consideration.

The President:—It will be so accepted.

Chairman A. L. Sparks:—Subject (7), Standardization of Metal Buildings and Parts, is shown in Appendix G, but there has been considerable information received since this report was filed. We very much desire to carry the subject further and would recommend that it be re-assigned to us.

The President:—We would be very glad to do that.

Chairman A. L. Sparks:—Subject (8), Use of Welding in Buildings, Collaborating with Committee XV—Iron and Steel Structures, is shown in Appendix H, and will be reported on by Mr. Hugo Filippi, Chairman of this Sub-Committee.

Mr. Hugo Filippi (Common Brick Manufacturers' Association):—The report of the Sub-Committee on welding may be found in Bulletin 334, pages 559 to 587.

The theory and practice of welding are passing through the formative stage of the work and new data arising out of research work in the laboratory and practice in the field are constantly being developed. The subject-matter of this report is based upon the best information available to the Sub-Committee at the time the report was written, but the report is not to be interpreted as a definite recommendation for approval of welding.

It is suggested that this study be continued as an open assignment for a short time so as to permit the presentation of supplementary information as it is developed.

The Sub-Committee moves that the report be received as information.

The President:—This is an example of a great deal of painstaking work in making the most of the subject-matter available. I think the Committee is to be congratulated on its presentation.

Is there any discussion? If not, it will be received as information.

Chairman A. L. Sparks:—Subject (9), Furnish the Special Committee on Clearances the Information Required by it Pertaining to Buildings, is shown in Appendix I. The Buildings Committee has collaborated with the Special Committee on Clearances and the Buildings Committee's report has been incorporated in the special report of the Committee on Clearances.

Subject (10), Sidewalks and Station Platforms, Collaborating with Committees VIII, Masonry, and XVII, Wood Preservation, Appendix J. The Committee recommends that this subject be reassigned for further consideration.

Subject (11), Elevators, Lifts and Escalators, appears in Appendix K and will be reported by Mr. O. G Wilbur, Chairman of Sub-Committee.

Mr. O. G. Wilbur (Baltimore & Ohio):—The report of this Sub-Committee is found on pages 588 to 605, inclusive, of Bulletin 334.

This report on elevators, lifts and escalators is presented as information. It includes a brief description of apparatus available for handling both passenger and freight vertical transportation. The Committee has made an attempt to offer solutions to individual elevator problems with which railroads may be confronted as this subject is one that is highly specialized. Attempt, however, has been made to explain in a general way the various classes of elevators and escalators now in use and to briefly describe their operation and capacity for service.

In dealing with the subject of escalators on pages 588 to 590, inclusive, only a general study is offered. The discussion touches on the possibilities of escalator installations in busy railway terminals. Some idea of escalator operation cost is given in Table I on page 589 for comparison with elevator operation cost shown at the top of page 591, if such a comparison should be desired.

In Table II on page 592, there is shown the passenger traffic handling capacity of elevators for various speeds, loads and rises in feet. The figures in this table take into account time for handling doors, loading and unloading passengers and time required for acceleration and retardation of cars.

The figures in Table III on page 596, covering time to run various distances (in seconds), also take into account the time required for acceleration and retardation of the elevator car.

Table IV on page 596 expresses average door operating time, and loading and unloading time. This is furnished for use with other data in the report for computation of approximate round-trip time of freight elevators in storage warehouses.

Table V on page 598 refers to typical freight car platform sizes and their relative rated loads.

Various types of elevators and methods of control are described on pages 598 to 602, and from pages 602 to 604 there is a general discussion of safety devices and the operation of doors and gates.

The elevatoring of office buildings is briefly covered on pages 604 and 605.

This subject is one that involves no conclusions and the report is therefore offered as information with the recommendation that it be accepted as such.

I therefore move the report be accepted as information.

The President:—Is there any discussion, gentlemen? This is some very interesting matter on the question under consideration. If not, those in favor of the motion will please say, "aye." Contrary, "no." It is carried.

Chairman A. L. Sparks:—Mr. President, this concludes our report.

The President:—The Committee is relieved with the thanks of the Association for its excellent report (Applause).

A

DISCUSSION ON ROADWAY

(For Report, see pp. 165-192.)

Mr. C. W. Baldridge (Atchison, Topeka & Santa Fe):—The subjects assigned to the Committee on Roadway are given on page 165. The action recommended is printed on page 66. To conserve time we will not read them.

The first subject, Revision of the Manual, is handled by Mr. M. M. Backus. Mr. Backus is Chairman of the Sub-Committee whose names are shown and which handled the subject. Appendix A (1) Revision of the Manual, will be presented by Mr. Backus.

Mr. M. M. Backus (Illinois Central):—Bulletin 330, page 167 to 169, Appendix A, covers the report now being given.

The suggestion made in Paragraph (a) is taken care of by the assignment for the following year.

Section (b) contains a suggestion that the term "common excavation" be used on page 28, Section 5 of the Manual, instead of the term "ordinary earth."

Paragraph (c) refers to methods of snow removal. On page 74, Section 13, the following words appear: "Salt should be used on switches only during that portion of the winter when the snow melts in daytime and freezes at night."

It is suggested that the following words be added: "except that the use of salt for snow and ice removal from station platforms near electrified tracks and from switches in electrified territory should not be permitted."

In Paragraph (d) a suggestion is made that the definition of "Soft Spot," where it appears in the Manual on page 50, be omitted, as the same definition appears on page 23.

In Paragraph (e) it is suggested that the definition for the word "Borrow (noun)," which appears on page 25 under "Grading," be omitted, as another definition appears on page 23.

I move that the changes suggested in Paragraphs (b) and (c) be approved for inclusion in the Manual, and that recommendations made in Paragraphs (d) and (e) be accepted.

The President:—You have heard the motion, gentlemen. Is there any discussion? If not, those in favor will please say "aye"; contrary, "no." It is carried.

Mr. M. M. Backus:—Paragraph (f) contains specifications covering the manufacture of concrete fence posts. These specifications were drawn up in collaboration with the Railways Bureau of the Portland Cement Association and were offered in substitution for specifications appearing on pages 68 to 71, inclusive, of the 1929 Manual.

Since Bulletin 330 was printed, some suggestions have been received which require consideration. Your Committee feels that the revised specifications should not be submitted for inclusion in the Manual at this time and wishes to submit the material appearing under Paragraph (f) as information.

The President:—That is the material on the next page and one-half?

Mr. M. M. Backus:—Yes.

The President:—If there is no objection, it will be so received.

Mr. M. M. Backus—On page 169 of the Bulletin 330, Paragraph (g), suggestion is made that when the Manual is rewritten, material covering specifica-

tions for metal fence posts appearing on pages 57 and 58 under "Roadway" be transferred to a position immediately preceding the material on concrete fence posts appearing under Signs, Fences and Crossings on page 68 of the Manual.

The President:—That will be taken care of in the rearrangement of the Manual.

Chairman C. W. Baldridge:—The second subject assigned to the Committee was methods of roadbed drainage, including study of deformations of roadbed in the light of data developed by Special Committee on Stresses in Railroad Track, with special reference to drainage.

This subject was handled by Sub-Committee 2. Mr. Fanning, Chairman of the Sub-Committee, will offer the report.

Mr. G. S. Fanning (Erie):—We are offering for inclusion in the Manual the material beginning about the middle of page 170 which starts with an outline of the subject of Roadbed Drainage. This is the outline which we have set up to be followed in working up the subject. For this year we have covered the outline down through the subject of surface drainage on construction. That material follows on pages 171 and 172.

I do not believe it is worth while to take the time to read it. Almost all of it is well-known to everyone. Almost all of it has heretofore been published in the A.R.E.A. Proceedings.

At the top of page 172 under Side Ditches there is an error in the printing, for which I am responsible. The last sentence of that article should read:

"The minimum side ditch should be one foot wide at the bottom and one foot deep below sub-grade, with side slopes depending upon the material. Side ditches should be constructed and maintained on a true grade, not less than 0.3 per cent with ample pitch at the outlet."

I move that this material, beginning with the outline, and down through Paragraph 4 on page 172 be adopted for inclusion in the Manual, replacing certain paragraphs which are listed on page 172 in the conclusion.

The President:—You have heard the motion. Is there any discussion? The subject of drainage is one that is always with us. It is one that every maintenance man should know a great deal about.

Chairman C. W. Baldridge:—It might be interesting to call attention to the fact that this subject has been reassigned and will be continued through the outline which Mr. Fanning has prepared, and which is found under the heading of Roadbed Drainage on page 170. We will continue that work next year.

The President:—If there is no discussion on the motion, those in favor will please say "aye"; contrary, "no." It is carried.

Chairman C. W. Baldridge:—The third subject assigned to this Committee was influences affecting the life of fence wire and methods for preventing its corrosion. Mr. Pruett, Chairman of the Sub-Committee, will present the report.

Mr. W. C. Pruett (Missouri–Kansas–Texas):—Your Committee has made a little progress on this subject. This report contains certain information assembled from tests conducted principally by the Santa Fe Railway and by the C. F. Burgess Laboratories, in conjunction with some wire manufacturers. There are other tests that are planned and some that are in progress now. The Committee feels that much more information can be obtained by a study

of these tests and by further information concerning experience of various railroads on this subject.

The report is submitted as information only, and we recommend that the subject be continued for further study.

The President:—It will be so received.

Chairman C. W. Baldridge: –The fourth subject assigned to this Committee was Permanent Roadbed, and Mr. A. E. Botts, Chairman of the Sub-Committee, will present this report.

Mr. A. E. Botts (Chesapeake & Ohio):—The continued study of this subject has not brought to light any new developments, and your Committee, on pages 175 and 176 of Bulletin 330, submits the further report of the Pere Marquette installations at Beech, Michigan, which is offered as information.

The President:—I wonder if anyone in the audience would like to ask the Committee any question about this subject. If not, it will be so received.

Chairman C. W. Baldridge:—Subject 5, as assigned to this Committee reads, "Good practices in grading, including making embankment and excavation by use of various kinds of equipment and by other methods."

Mr. H. T. Livingston, Chairman of the Sub-Committee, will present the report.

Mr. H. T. Livingston (Chicago, Rock Island & Pacific):—When the subject was assigned, no hint as to those features to be discussed was given. Report submitted does not attempt to specify what shall be done to secure proper cuts and embankments but does outline some of the methods, now in use, that have proven to be successful. All information that was received by the Committee indicated that contractors cannot be too fully informed before submission of bids on detailed work if extra bills, additional payment, and so forth, are to be avoided on final settlements.

I overlooked one feature in going into this, and that is the necessity for Engineers, especially those that are charged with the proper use of specifications, to give close attention to require contractors to live up to specifications and to know what the specifications contain. When we prepared this report, the principal feature uppermost in the Committee's mind was difficulties that we ourselves were having with contractors' selection and disposition of equipment.

The report is submitted for informaton.

The President:—It will be so received.

Chairman C. W. Baldridge:—Subject 6 as assigned to this Committee reads, "Drainage areas, water runoffs and the proper sizes of waterway openings required under varying conditions." The Sub-Committee handling this subject did a considerable amount of work this year, but towards the end of the season when it was time to get up the report, Mr. Johnson, who was Chairman of the Sub-Committee, was called to Washington on valuation work for his Company and was unable to prepare a report. Therefore, we had no report on this subject this year. The subject has been reassigned and will be continued another year.

Subject 7, methods of correcting soft spots in railway roadbed where it is impracticable to stabilize by drainage. Mr. Swartout, of the Missouri Pacific, was and is Chairman of this Sub-Committee, and had the misfortune of being confined in the hospital for several weeks toward the latter part of the summer and autumn and was unable to complete his report for this year. The subject has been reassigned and will be continued in next year's work.

Subject 8, use of highway crossing plank and substitutes therefor, collaborating with Committees V, Track and IX, Grade Crossings. Mr. Hillman, Chairman of the Sub-Committee, is absent, I believe, and Mr. Oyler, member of the Sub-Committee, will present the report.

Mr. E. C. Oyler (Pennsylvania):—The subject assigned to this Committee is study and report on the use of highway crossing planks and substitutes, collaborating with Committee V, Track and Committee IX, Grade Crossings.

The Committee's report in Bulletin 330, Appendix F, page 180, emphasizes the need of more definite and authentic information as to the life of different materials and also the need of more accurate cost data. Description is given of a test being made by the Chicago, Milwaukee, St. Paul & Pacific Railroad in Chicago. There is also a report on a steel plate and angle crossing placed some ten years ago on the Chicago, Burlington & Quincy Railroad. Some comments are made on concrete slab and plank installations together with notes of practice or experience on three other railroads. There are also comments on rail type, bituminous and specially constructed plank crossings. This report is submitted as information with the recommendation that the subject be continued for the next year's work. The Committee will appreciate any information sent us giving cost data, life studies, and so forth.

The President:—That report is submitted as information. It will be so received.

Chairman C. W. Baldridge:—Subject 9, methods of roadway cross-sectioning calculations, measurements for monthly and final estimates, etc. Prof. Vawter, Chairman of the Sub-Committee, will present the report.

Prof. J. Vawter (University of Illinois):—Appendix G will be found on pages 183 to 188. Material contained in this report can be found in various forms in several textbooks and it also represents practice on a number of roads. The methods of calculation that are here given have proved satisfactory and are better than some methods that are used. They are presented more for the use of the younger fieldmen. This report is presented as information only.

The President:—Is there any discussion of this matter? If not, it will be received as information.

Chairman C. W. Baldridge:—Subject 10. There was an additional subject assigned after the original assignment of this Committee, and it caused a little mix-up in the numbers. It covers cause and prevention of heaving of track, due to frost action, and maintenance methods while the effects of heaving are present, collaborating with Committee V, Track. Mr. C. S. Robinson, Chairman of this Sub-Committee, is not present, and I do not believe there is anyone here that was on that Sub-Committee.

The report of this Sub-Committee is found in Appendix H on page 189, Bulletin 330. The report covers the cause of heaving, prevention of heaving, giving an illustration of damage to ties resulting from heaving track, and on page 190, maintenance methods. On page 191 it gives copies of plans of shims and braces used in taking care of heaved track. On page 192 are likewise plans for shims.

This report is offered as information.

This completes the report of the Roadway Committee with the exception of a lecture on drainage, illustrated by lantern slides, which will be given to us by Dr. G. E. Ladd.

Dr. Ladd ran these pictures and delivered his lecture to the Committee at one of our meetings last summer, and we found it very interesting indeed, and I am quite sure that all of you will be well repaid by staying to see the slides and hearing what Dr. Ladd has to say (Applause).

Before Dr. Ladd starts his talk I want to add a little to what I should have said when I was introducing Dr. Ladd. Dr. Ladd has made a lifetime study of drainage subjects as Consulting Engineer on that subject with an office in Washington, D. C., and is certainly an expert in this line. I hope that everyone of you will find it worth your time to listen to this lecture.

Dr. G. E. Ladd (Consulting Geologist):—I have heard from many quarters that this is a limited meeting and I have spent a good part of to-day revising what I was going to bring to your attention tonight in the interest of elimination and limitation. I have a brief statement that to-day I put in writing and have had typed in order that I might make it as concise as possible before we run our pictures.

The term "Drainage" must be broadened in its definition and significance, in three ways:

(1) It must cover not only water-elimination, but prevention and limitation of access of water to the natural or artificial earth-mass under consideration.

(2) The *kind* and *condition* of *materials* involved must be considered in their relations to water. How do they react to water-behavior, to water, either as an erosional force, or a lubricating one, or both? Literature on drainage is particularly barren and unsatisfactory on this phase of the subject.

(3) The source, or sources, of troublesome subsurface water must be found, in most cases, through correct interpretation of local geological conditions.

This is another phase of the question pertaining to materials, a broader one, in that it is related often to adjacent formations and their conditions.

A little progress has been made on a part of these subjects, mainly through highway subgrade studies, but as yet, only the surface of them has been scratched.

My talk tonight will stress these aspects of drainage. I can only hope, in the limited time I have, to impress upon your minds a picture of the problems and something of what they involve.

In passing, I wish to emphasize the fact that there is great magnitude to the money losses annually suffered through lack of perfected control methods. I believe them to amount to over $5,000,000 per year to highways and railroads. Also the element of safety to trains looms large in this connection.

We know, and the public knows, how rare are train wrecks in spite of the enormous mileage annually traversed. Nevertheless, a considerable proportion of the few that do occur result directly from the unsolved (or neglected lessons from) mysteries lying in the relationship between materials and water. That there are not more accidents is due to the extraordinary precautions you effect in train operations, in times of indicated danger.

The point is, that one preventable accident, resulting from subsidence, slides or washouts, is a thousand times too many accidents.

Given a little more light, there will be no accidents of this class, and important economies will result from lowered maintenance costs.

Before showing you my illustrations, I wish to say a word or two, specifically, about materials, and the ambiguity and error prevalent about them.

You will find, in drainage and foundation literature, endless simple contrasts drawn between the behavior of *sand* and that of *clay*. Unfortunately, these terms are generalized. Yet, highly rounded sand, of any size, behaves with vital difference from angular sand. Demonstrate it! Dump on this floor a load of broken stone, then a load of marbles, and measure the "angles of repose" of both, if you can.

I once found a concealed pocket, beneath a main railroad track, of over 100 cubic feet, where, perfectly dry, round sand had rolled out and down a slope through a hole started by a gopher, and jarred loose by passing trains. I have read many weird explanations of what "quicksand" is. There is no mystery about it. It is merely rounded sand, usually fine, under water.

The *shape* of clay particles is also vital. Many thin plates in them make them capillary and plastic. Clays vary enormously in this respect. Some will absorb but little water—others as much as 200 per cent by weight. Some are impervious under any natural conditions, and others become so as soon as slightly wet and before becoming plastic.

Colloid content in clays is another matter.

If the facts stated are true, and the questions raised are pertinent, what is the answer? Not long ago I was discussing these problems with a high and widely known railroad official, and he expressed the belief that each case called for special interpretation; that generalizations would not help much, and that solutions must be found as needed, by individual railroads. I think that view does not square with the facts. There is a language, but little known, which consists in part of engineering and in part of geology. With it there has been drawn by man and nature a complete picture of the problems, and a key to their solution. Unfortunately it has been cut up as a jig-saw puzzle and the pieces indiscriminately scattered among various railroads. Who has the time, opportunity, or inclination to assemble and interpret them? It remains to be done.

Long before the time of Christ, man had noted certain obvious relations between water and materials. So, the parable of Jesus about the wise man and the foolish man building on rock and on sand. As to the subject of water-cut-off beneath the ground, Julius Caesar closed his Gallic wars by tunneling to the sources of a spring and ending water supply to the enemies' fortified camp.

I shall touch, later, for a minute, on the subject of the occasional fall of boulders.

(Dr. Ladd commented on the lantern slides briefly, as follows.)

The first set of views will show you moving earth which consists of débris resulting from the weathering of shales, and interbedded sandstones or limestones. This is a natural slide of which we have thousands, neither made by cutting of a stream nor artificially. Very often the problem in connection with these is: How much is moving? We have a mountain, a great hill above us. Is the whole thing coming? I have known of a railroad that moved a four track system away from a series of slides of that nature, when perhaps the sum of $25,000 or $30,000 would have ended the trouble because it was nothing more than a "skin" of earth that was actually moving, or could move.

This is another type of accumulative débris, thicker. It seldom reaches a thickness of more than fifty feet, because it moves, it is on the move. A great deal of the topography of the state of West Virginia has been molded not by erosion but by slides. This is a California view and if that type of moving earth is not controlled in the early stages, it will constantly progress, particularly where it is removed at the base, naturally or artificially. I have seen them work back for a mile.

This is an old débris slide that moved again when it was cut into after a rainy spell. It cost the railroad company something like one and a half million dollars. It was unnecessary, and if there had been available literature on such problems it would not have happened. It carried out all the public utilities and 35 or 40 residences, and so on. You note a great deal of piling, put in as a desperate, temporary expedient. Of course it was all wasted.

This is a decomposed shale on the Pacific Coast. It is a famous slide. Much has been published about it. You will be interested to note the type of piling, and binding together, seen in the foreground of the lower picture. The ground is pretty thoroughly riddled with tunnels. It is too long a story to tell you about it, but look at the upper left-hand end of the lower picture and you see a white area. That is a Gunite job. In some technical articles it has been claimed that it cured this slide. But these are the facts: first, it has not been cured; second, that work protected an electric structure behind it and had no relation to the slide. It is on solid ground, and serves only to prevent weathering of shale. That slide heaved up a railroad track and threatened for years to overwhelm it. You can get some idea of the amount of dirt removed from it, by the topographic basin occupied by the slide.

Speaking of materials, you would hardly expect material like that (a mass of large boulders) to move, but if there is enough clay padding in it, of the right kind, and the water supply be sufficient, such material is unstable. In the State of Vermont that type of slide is not uncommon.

This is a Mid-western picture, showing 100,000 cu. yd. of earth and rocks precipitated upon railroad tracks as a result of widening of roadbed. Double tracking and a cut caused this slide. The problem, then, was how much material to remove. When are we safe?

This is a topographic map of a slide in the Far West, one of a great many from which one railroad suffers. It is the most interesting landslide I have ever seen. It is of the glacial type, and, in behavior, has many of the attributes of a glacier. It is 1800 feet in length, 900 feet in the widest part, and only 150 feet at the discharge end.

It has been costing the railroad company something like $15,000 to $16,000 a year for 15 years.

This is a detritus slide. Here you are looking at a highway and railroad, although they are not evident because they are buried. In this view they are about 30 feet under the surface. It took 30 days, with power shovels working at both ends, to clean up.

This is a northeastern view of sidehill slips, and the repair work. There was too much pile driving there; I mean in that whole district.

This is a view of the famous Pittsburgh slide which moved from a slope belonging to the city upon the railroad tracks. I understand it cost the latter one and one-half million dollars. I believe that $30,000 or $40,000 spent in

drainage of the right type would have prevented it. A huge retaining wall, and two lines of cribbing went out with the slide.

We often have upheavals. You get them on highways, you get them on railroads, and on trolley lines. This is an example. They are easily preventable.

A case of concrete pavement destruction. I have seen that sort of thing, very much worse, extend for two miles of a concrete paved road. Thousands of such half-fills "go out."

This is a type of road destruction characteristic of the action of many slides.

This is where a railroad *was*. Parts of track you see in lower foreground Here the railroad was located on a slope of shale shattered by a geological fault.

We jump to another cause here; another type. That fill which you see has been moving for years; ever since it was built. The constant presence and operation of a steam shovel is necessary. Although the material involved is a type of lava, there is a very peculiar mineral that has formed about all its fragments. It is called antigorite. It resembles, in this form, talc, and makes all the rock fragments very slippery. Strange to say, in the same mountain range 2,500 miles away I found another slide due to identically the same cause.

We have here the descent of an earth mass upon a track just in time to wreck a train. This is a different type of material, not débris; it is an original, clay formation; a glacial lacustrine clay which is very dangerous in its behavior, and which is very common in a wide region surrounding the Great Lakes.

Here again is another type. These are the marine clays of eastern Canada north of the St. Lawrence River. Most fortunately they are not closely related to railroads, because they move on an enormous scale. More than 250 lives have been lost in such slides. Farms have been moved great distances with orchards still upright. Frequently, the movement is through a narrow break in a ridge, and up to 85 or 100 acres, from 50 to 100 feet deep, move out over night.

At the extreme upper edge of the slide you see a white farmhouse. The farmer awoke one morning (everything was all right the night before), and right up to the verge of his house was this scene, 35 acres of the farm gone to a depth of 50 feet. He was not much concerned because he had had a worse slide on his property before. He would soon be farming the flat valley floor of this slide.

Here is another type, not so far from Chicago. This is where material squeezes out at the bottom either because it consists of rounded sand, or a plastic, wet clay. Ten days after this photograph was taken oak trees that had been in the yard of one of these residences—all very fine places along the lake—were 20 or 30 feet down.

The report of one Engineer in regard to the trouble there was to the effect that the materials moved out ***beneath*** retaining walls, and beneath the level of the lake. All the evidence I got in studying a mile and a half of it was that the squeezing plane, the bottom of it, was above the level of the retaining walls. The movement usually destroying them, but sometimes sweeping over them.

The small oak tree which you see out in the lake, has dropped 100 feet vertically, and moved about 260 feet horizontally. It happens to be still erect.

Here is another type, not so much related to drainage. I put it in because it shows a type of unstable rock. It is a view of a structural slide where undercut of dipping strata has been made. Conditions leading to such slides are particularly dangerous if, as is frequently the case, there are thin layers of clay, or clayey shale, between the hard rock strata.

This is a view of a 45-degree slope of a massive sandstone, 15 feet in thickness, with a half inch to an inch of clay between that and an underlying limestone. Several acres of this massive sandstone slid to the river below. It was due to a highway cut.

Here is a view of a railroad tunnel in the immediate vicinity. When the several acres of rock went out, as shown in the preceding view, a great fissure formed which runs up diagonally above this railroad tunnel. There is a serious menace to the railroad here. If there should occur, locally, one of the little earth tremors that we occasionally have, even in the East, an immense mass of rock will be precipitated. I think it could be pinned down rather inexpensively.

Here is the result of undermining through an open cut, 2500 feet long, of just such a dipping rock slope—a pretty expensive outcome to the railroad. The trouble also involved a nearby tunnel.

This is a natural slide, one of the largest we have had in the United States in historical times—55,000,000 to 65,000,000 cubic yards. Such slides are not preventable. It is a *structural* slide, by the way.

When you have conditions like this, you can usually locate on the other side of the river valley, and avoid the side where such a thing is likely to happen. In this case it would not have mattered, because the slide crossed the wide river valley and piled up 300 feet high, against the mountain on the other side.

Underground seepage, not so easy to detect in the summertime. This is a view taken in a cut, in shales, with associated thin seams of shattered limestone, at the point where we saw one of the $1,500,000 slides in a train yard. That was taken on a hot, sunny day. Nevertheless, the water seepage is evident.

This may deceive you a little (stratigraphic seepage). Winter is the time to note how seepage acts because the results are cumulative. If you should go to Cleveland and out Euclid Avenue to the little town of Euclid, and on east toward Buffalo, you would traverse a road where some winters there are two or three feet of ice for a long distance, due to the accumulation of such seepage. That gives you an idea of what happens underground when certain stratigraphic conditions occur. Geological conditions have to be taken into consideration when we are going after the source of water.

This merely shows you how non-continuous such seepage flows are, occasionally only in spots.

In Mason County, West Virginia, I was told that the fills (side-hill fills), were going out at regular intervals on a certain new road that had been constructed and concrete paved. I went down to look at it and that was the condition I found. Note that the sandstone and shales are regularly folded into slight synclines and anticlines. The almost horizontal line across the diagram indicates the highway level, and you see how it cuts across the geological structure. It became evident almost instantly that wherever the

fills went out, it was where the dips were, because there the heavy seepage escaped directly into the fill, but where the upthrows are, the anticlines, such water as came through the jointed sandstone fell into the ditch and was carried away as surface water.

We come to another aspect of materials. Here heavy rains have come and water has flowed a few inches deep, only, over a railroad track that was ballasted with light, fine material. That is gone, of course. In this particular case it led to a great disaster.

There are literally thousands of cases of this sort in highways. Sometimes it is only local; sometimes there are miles of it.

I put this view in because I am frank to say I do not believe that the accident that happened here to a freight train could have been prevented or foreseen. Thirty-four cars of a freight train went down that hillside. Topographic conditions compelled a stretch of unfortunate location.

This is a very interesting type of fill subsidence. Three tracks, ultimately, of the four-track system went out of commission.

There was a large flow of water from the bottom of that fill. I never saw a serious subsidence where the cause (water source) was so obvious, even to cursory examination, as it was in this case. On both sides of the fill, on top of a shale, massive, impervious, was a thick stratum of jointed sandstone from which at various points outside the limits of the fill, springs were then flowing. Two pagodas of a little summer resort were supplied with fountains by sticking pipes under the jointed sandstone bed but I could not get any railroad official concerned to appreciate the significance of this fact. Three thousand dollars would have tapped the sources of water trouble, but as they had a right to do, another method of control was used. A large culvert, at a cost of $50,000 or $60,000, was extended, and the fill slope reduced. Reducing the angle of slope is all right if you are sure the fill is not going to subside in spite of the reduction. A large volume of water still flows from the toe of the fill.

This is an interesting diagram of a highway fill. I examined it for the highway department of one of our Eastern states, and told its Engineers where the water came from, and what they had to do to get it and cut it off. They said, "We dug a trench there." "How deep did you go?" "8 feet." "You didn't go deep enough."

They have plenty of money. One day I got a telegram from them which read, "Wish you would come out and see what that trouble was. We have found it."

I went and discovered that at a cost of $60,000 they had removed the fill, and the water source was exposed, a dripping coal seam. The water source was where I had said it could be found. This view illustrates the source of water that saturated that fill. Seventeen thousand board feet of cribbing had been put under the pavement in a determined effort to save it, but it was unavailing. The lesson is: go to the source of water, and cut the water off.

This is up near Lake Superior and is an example of the troubles they have. They are very serious there, for this type of flocculent, fine, light, clay moves with great readiness.

This is another type of fill subsidence (fills on mucky ground), with which you are familiar, as well as the remedies for it. The tremendous up-

heaval on the sides are not shown, but you know how they occur and what has to be done. There are no geological mysteries about it.

I have introduced this picture, not to show a wreck, but to show what can happen, and why, when the approach to an abutment goes out during a big flood, if conditions are right.

This is another type. There have been a number of accidents, like this one, often where normally heavy rainfalls are not expected. Such accidents may occur wherever you have pile or frame bridges, at a time of heavy floods. Scouring of materials, under certain conditions, can be affected by the flood. I wish to say, before leaving this subject, that I think all of such scouring can be eliminated at very low cost. That matter will have to be taken up in an article for publication.

I said I would mention the subject of falling boulders. I have known of three or four people being killed by them, and saw one truck smashed by a boulder fall. I have been nearly killed myself by one. I saw a slab of 18-foot, 7-inch, concrete pavement dislocated at one end two feet, and split for a distance of 200 feet by a falling boulder. I know of three railroad accidents that have been caused by them. On three inspection trips that I have made on railroads, I have pointed out dangerous boulders, and they have been blasted and removed. Sometimes boulder falls cannot easily be foreseen, but it is worthwhile, wherever you have height, and bouldery or jointed rock ground, to make careful surveys.

In this case (a train wreck), an enormous boulder fell from a height of 700 feet and from a distance of something like that, leaped over a highway, took out the two upper strands of a telephone system, struck the outside rail of the track, made a sharp V in it and also broke it. It was a most extraordinary occurrence. It then bounded beyond the track.

Here again is our theme: the relation of materials to water. This is a most innocent looking little country road, but it had a 9 per cent grade, sloping directly to the crossing, with pebbles on it. Heavy rains came. Pebbles were washed onto the track, especially just in front of the truck, seen in the left foreground. A train going 50 or 60 miles per hour hit them. The wheels of the tender jumped the track and 200 feet beyond caused this—(slide, showing picture of train wreck). Of course the lesson is obvious now, but the disaster and its cause are two of the many things that we should keep in mind so that such a wreck may never happen anywhere again.

Here is a bad slide in the suburbs of a very well known Eastern city. The control methods employed here are about the worst that were ever undertaken. You will note in the left lower foreground the remains of a retaining wall 400 feet long. Only a fragment of it was left. The wall, to protect the highway, was based on long steel sheet-piling, the object of which apparently was to keep the water in the sliding mass and help it to slide more. You see a black line traversing the center of the picture and across it. That is more sheet piling to hold more water. The rectangular rock mass is a trench drain system, put down to a depth of five feet, and utterly useless.

Of course, there are many ways of removing the material that comes upon you. In the far West, instead of steam shovels, they very frequently use these hydraulic jets and reduce the cost to something like six cents a yard. I am running over a few methods of control.

One of the most extraordinary things I have seen, when all the evidence is massed, is the number of retaining walls that have been built on no substantial base. What good is a retaining wall that is not properly founded? Also, they may not be so very well built. This one you will note is crumbling. It had been strengthened, and above it are two rows, enormous ones, of cribbing. The whole thing went out. This is one of the slides so famous that cost from one and one-half to two million dollars.

This is another retaining wall. It is one of a great number of failures. The far end of it went out, and they substituted, not ordinary piling, but what is very largely used in certain Eastern states, re-enforced concrete-filled casing; drilling and putting it in. It was started as an experiment and the method spread regardless of adaptability. The trouble is there is a lot of guesswork, and when we do not quite know what to do, we are apt to follow our neighbors' methods, whether they apply or not.

Here is a retaining wall, the best type I ever saw. It is 100 per cent, i.e., as wide as high. You happen to have in your Proceedings a view of this scene just before this slide happened. Notice break in the wall at the center. The far end is shoved out about 20 feet.

Here is a case of utterly unnecessary building of a retaining wall. Note the stratification exposed. Note how close to the surface it rises. There was not more than six or seven inches of movable material under the pavement which they sought to protect. Lowering the grade slightly here was all that would have been necessary.

So far as wooden piling goes, there are vast forests turned upside down and driven into the ground. When you begin using them you never know where to end. I have seen ten rows protecting one piece of highway.

This is a type of clay which, when wet, flows right through piling, as it is doing in this case. It is common, for example, in Eastern Ohio.

Here are some of the reinforced concrete-filled casings which failed. Previous to their installation (there is both a highway and railroad involved) there had been ordinary wooden piling, not very effective. It ultimately went out into the stream. Then this method was tried. At the far end of the road you see the beginning of failure. Later it all "went out."

Here are rails used as piling, and some of that type of casing seen in the preceding view. It will hold if the critical points of load and water content in the given material are low enough.

Here are some of the old-fashioned cribbings rotting, and giving way (because they are in the neighborhood of that type), to concrete-filled casing.

Here, in the home of it (case-piling), the state that practically gave the method birth, is one of the many places where it has failed. Now, instead of going after the water, they are building a retaining wall. That will probably follow the casing.

Not infrequently counter loads are put at the base of fills. Both sides of the railroad fills that you see on the upper left of this picture are loaded with these boulders. It happens that they did no good whatever.

Here is a case of the combining of two methods. In this case it worked. I might mention, here, that dynamiting is frequently a control method. In nearly all cases its beneficial effects, if any, are temporary. Another, and often successful method that has been tried on many bad fills, is throwing buttresses of earth out from the fill.

This is a reinforced-concrete cribbing failure. Of course, like any other cribbing, it is no better than the foundation on which it rests. In one county not so far from here, I saw on one visit over $80,000 worth of it "go out" more completely than that shown in this picture.

North of Lake Erie "runs" form through a type of earth movement, where a lowlying stratum gives way, and squeezes out. If there is running water or frequent rain, the materials wash away. These runs develop very rapidly, and if they are not controlled will destroy an enormous section of farming land.

This method (control of "runs") is an excellent one, and where it has been tried, has worked splendidly. You see the drainpipe loaded with a few feet of fill. This drain takes care of the seepage water, and the system, as installed, prevents the removal of material, and extension of the trouble.

Here is an ideal case of drainage. It is a highway slide. They had one from above, and a great section of road went out below when they widened the road, added to the load, blanketed the side of the fill, and choked in the old outlets of seepage water. I tried to get the engineer in charge to see the point and drain it. He was stubborn about it until one day when I happened to be there with him, a large section of the road dropped vertically and exposed a section of the "solid" from which water was pouring. Then he said, "I am ready." So he put in this trench, down into the "solid," at a good grade. It happened to be for a long distance. A six-inch tile drain was established in the solid, and it has flowed about half full ever since. There has never been another movement of the earth.

Thank you very much, gentlemen (Applause).

The President:—Dr. Ladd, I want to thank you on behalf of the Association for this highly interesting and instructive lecture.

Dr. G. E. Ladd:—It is an honor to have been able to be with you and to talk to you on this subject in which I am very deeply interested.

The President:—This concludes the report of the Roadway Committee and it is excused with the thanks of the Association (Applause).

DISCUSSION ON SIGNALS AND INTERLOCKING

(For Report, see pp. 627–639.)

(Vice-President J. V. Neubert in the chair.)

Mr. W. M. Post (Pennsylvania):—The report is found on page 627 of Bulletin 334. The first report is on Developments of Automatic Train Control and Cab Signals, and will be presented by Mr. Ellis, Chairman of the Sub-Committee.

Mr. G. E. Ellis (Automatic Train Control Committee):—The report is printed in full in Bulletin 334, page 627, and it will hardly be necessary to read this in detail. But I should like to call attention to a few developments which have taken place since this report was printed. There have been various opinions expressed as to the future of train control. The Interstate Commerce Commission through the Assistant Director, Bureau of Safety, although I think it was unofficially, was behind the statement made at the Signal Section meeting in Hot Springs, Arkansas, last September, in which it was said that the Commission was entirely satisfied with the results of train control, and was prepared to issue additional orders if felt necessary. The meaning probably was

it would not issue a blanket order, but in case of serious accidents would call to the attention of the carrier concerned, by a suggestion that it increase its train control or cab signals.

There have been only one or two suggestions by the Commission since then, and no definite action has been taken, but it is certain that the Commission has not abandoned the thought of train control where, in its opinion, it thinks it is necessary.

As to the subject of installations under the orders of the Interstate Commerce Commission, these have all been completed now and all of the roads except four or five have been notified, that their installations, in most cases, were satisfactory, and have met substantially the requirements of the Commission's orders. There have been a few criticisms made which are now the subject of negotiation. These particularly refer to questions of maintenance and things of that kind and are in a fair way to be adjusted without difficulty in a short time.

The Automatic Train Control Committee of the American Railway Association has been looking into the question of interchangeability of devices. We have hardly called it standardization, but the problem is to try to find a way in which the different devices can be made to work over the same territory. Some progress is being made on that but we have not thought it advisable to spend a large amount of money as yet on those investigations.

The Commission has recently been working on some specifications for cab signals, involving some definitions, so those shown on page 629 will probably be slightly modified in the negotiations which are now in progress.

As most of you probably know, the Pennsylvania Railroad has been given permission, following a petition by that company, to use engines equipped with cab signals on train control territory, under certain conditions. The Pennsylvania now has, according to our information, 1192 track miles operated under cab signals alone. This is in addition to the mileage which is worked under the train control orders. About 200 multiple-unit cabs have been equipped for operation under this scheme.

I should like to read one or two extracts, which may be of interest, as indicating the attitude of that body. It is not impossible that other carriers may want to take advantage of the same opportunity granted the Pennsylvania. The report was by Division VI of the Commission, Commissioners McManamy, Eastman and Lee. There was no dissenting opinion, although Commissioner Eastman made a few comments.

This report was the result of a hearing following a petition by the railroad and was held on December 23, 1930. The opinion was decided on February 6 and released a few days later. The railroad sought approval of the use of four indication cab signals operated by what is called the continuous code system as installed on the railroad, with a loud whistle sounding whenever the signal indication changes to a more restrictive indication and continuing to sound until acknowledged by the engineer or fireman. Permission was granted to operate in interdivisional runs locomotives so equipped, when said interdivisional runs cover in part the territory where the orders now in effect require the use of automatic stop or train control devices, installed in accordance with specifications prescribed.

The Commission expressly states in its opinion that no provision of the act under which approval of train control is required, applies to voluntary in-

stallations, and the Commission further states that its orders of June 13, 1922, and January 14, 1924, provide only that installations made according to that order shall be subject to approval as provided.

Further consideration, therefore, was not given to the request for approval in the use of this device on divisions not covered by the orders.

"The testimony presented in this proceeding, based upon experience in the use of the cab signal device, is very convincing that its use will promote safety, efficiency, and economy of operation. It is believed, therefore, that for the above reasons and also in the interest of the further development of the art of signaling, opportunity should be afforded to acquire additional experience with this device. No more conclusive test could be suggested than the operation over the same division of locomotives equipped with the automatic train stop device and with the cab signal with whistle and acknowledger without the automatic train stop device. Therefore, until our further order, permission will be granted to operate in interdivisional runs, over territory in part equipped with train stop devices, locomotives equipped with four indication cab signals (one for the engineer and one for the fireman) with a loud whistle which sounds whenever the signals change to a more restrictive indication and continues to sound until acknowledged, operated by the continuous coder system as installed on the divisions above referred to on the Pennsylvania Railroad. This permission in no other respect modifies our former orders requiring installation of automatic train stop devices on certain divisions and the equipment of locomotives assigned to such divisions with automatic train stop devices as ordered, and it will in no way relieve the carrier from maintaining the automatic train stop apparatus now installed on its locomotives in compliance with outstanding orders in accordance with the requirements of said orders."

This quotation from the Commission's report indicates apparently a very open mind on the subject of cab signals, although it restricts the order to the direct terms of the petition.

Commissioner Eastman's concurring statement, with comments, will be of interest: "I have no objection to the conclusion reached that the permission sought should be granted, largely for experimental purposes, but I do not endorse all that is said in the report. The evidence in this case was of an ex parte character, presented by a petitioner which is no doubt sincerely convinced that this coder system represents the last word in train protection. I am by no means convinced of this fact. In my judgment the automatic-stop feature introduces an additional element of protection, and the objections which have been offered to that feature are quite capable of being overcome."

I believe that is all that need be said at this session.

Vice-President J. V. Neubert:—This report is received as information, and I would like to find out if anyone in the audience would like to ask Mr. Ellis or Mr. Post any question. Mr. Ellis is Secretary of the Automatic Train Control Committee which has been functioning for several years.

I know that a great many of you here have read a great deal about automatic train control and possibly this cab signal indication which is now being used on the Pennsylvania, and they are going to use it more extensively.

I assure you that Mr. Ellis, who is well qualified, would be very glad to enlighten you on anything you would like to know.

Yesterday through a certain period I think you were a little bashful in regard to asking questions. We had time yesterday and we kind of drifted along and quit about fifteen minutes ahead of time. Don't be modest. If

you want to ask anything, please do so, and the Chair will recognize in case you impose on the time of some other Committee. Can I hear from somebody?

I would like to hear from Mr. Wiltsee, who is Chairman of that Automatic Train Control Committee.

Mr. W. P. Wiltsee (Norfolk & Western):—I do not know that I could add anything to what Mr. Ellis has said except probably to review a little the work of the A.R.A. Committee. As most of you gentlemen probably know, there has been an A.R.A. Joint Committee composed of five members of the Operating, Signal, Engineering, and Mechanical Divisions. This Committee has offices in Washington, and Mr. Ellis is Secretary. Mr. Ellis, of course, does most of the work.

During the past two years the Committee has published eight or nine bulletins giving a complete history of automatic train control to date, listing all the installations and giving complete details. Those bulletins are available to everyone, and Mr. Ellis also has arranged for binding. The bulletins or bound volumes can be obtained from Mr. Ellis by corresponding with him.

During the past two years especially the Committee had devoted a good deal of its time towards interchangeability of the devices. They have a fund for that purpose, but just at present they are somewhat handicapped in actually demonstrating the interchangeability on various railroads, but the work is progressing and results are very favorable.

Vice-President J. V. Neubert:—Thank you. Anybody else?

Mr. G. E. Ellis:—I would like to supplement what Mr. Wiltsee said about the bulletins. These were prepared primarily as a report of the Committee's work to the American Railway Association, but we had printed a surplus number of copies and we sell these at just about actual cost. We are, of course, desirous of disposing of the extra copies and want to put them in the hands of the people who will really be benefited by them. It is as complete a treatise, we believe, as has been published on train control, at least in this country.

Vice-President J. V. Neubert:—If there is nothing further, the report will be received as such.

Chairman W. M. Post:—The second report is found on page 634, Appendix B, Improvement in Railway Operating Efficiency. This study was made by Mr. H. M. Sperry, who is a member of the Association but not of the Committee. We are very much indebted to him for the research he made. Data was obtained from reports by the railroads to the Interstate Commerce Commission.

The first step in the survey of the situation was a study of the improvement in freight train performance made during the past ten years by the 47 railways with annual operating revenues above $25,000,000.

The roads were divided into three groups on the basis of the ratio of the miles of road equipped with automatic block signaling to the main line miles of road.

These three groups are shown in Table I and also in Chart I on page 636.

Group A comprises roads with a ratio of 60 per cent or more of automatic block mileage of road to the main line miles of road.

Group B comprises roads with a ratio of 30 to 60 per cent, and Group C roads with a ratio of 0 to 30 per cent.

On Table I, you will notice that the gross ton miles, Group A, increased 2 per cent in ten years, train miles decreased 9 per cent, and train hours decreased 30 per cent.

In Group B, gross ton miles increased 23 per cent, train miles decreased 4 per cent, and train hours decreased 26 per cent.

In Group C, gross ton miles increased 38 per cent, train miles in this case increased 8 per cent, and the train hours decreased 14 per cent.

In Table II, the first column heading "1919" should be 1929. This table shows total miles of road, main line miles of road, and the automatic block miles of road, and the ratio of automatic block to main line miles of road for years 1920 and 1929. This is shown for the three groups, and the average for all of the groups.

In referring to Chart I, it will be noted that Group A, with an average of 85.6 per cent of the main line miles of road equipped with automatic signals, the gross ton miles per train hour was 27,817; in Group B, with automatic block ratio of 30 to 60 per cent, the gross ton miles per train hour was 24,866; and in Group C with automatic block ratio of less than 30 per cent, the gross ton miles per train hour was 21,952.

The report does not show the tractive effort of the locomotives, but it was about the same in Groups A and B, somewhere in the neighborhood of 57,000, and it was somewhat less in Group C. We thought it rather interesting that the gross ton miles per train hour was higher in the roads with the greatest percentage of automatic signals in relation to their main line mileage.

It is not claimed that all of the improvement in operating efficiency is to the credit of automatic block signals as automatic block signaling was only one of the many improvements made by the railways during the past decade.

Capital expenditures of the railways for improvements for the last ten years aggregate nearly $8,000,000,000, covering new equipment, roadway and structures, additional tracks, heavier rail, car retarders, automatic block signals, centralized traffic control, and other items.

It is, however, claimed that the use of modern signaling systems; automatic block, centralized traffic control for train operation by signals, interlocking, remote power switches and spring switches, all made their contribution to the elimination of train delay and that no small part of the 26 per cent saving in train hours is due to the use of modern railway signaling.

If the railroads had not improved their performance in 1929 over that of 1920, the train hour expense for 1929 would have been considerably greater than the amount actually paid out. For example, if a train hour had a value of $20, the saving was approximately $275,000,000.

In Chart I that information is all shown graphically. This report is presented as information.

Vice-President J. V. Neubert:—Does anybody wish to have any discussion on this report?

Mr. J. E. Teal (Chesapeake & Ohio):—In reading this report the question naturally arises as to what other factors may have an influence on the increased efficiency in train operation. I wish to say that the Committee on Economics of Railway Operation has made a number of studies along this line and I have noted a number of factors that have considerable influence in the economies of train operation or the more efficient operation of train service. I will just read these items:

Extension of and additions to passing sidings on double and single tracks; additional double and multiple tracks; grade reduction; improved and heavier power; water treatment; large engine tanks; improved maintenance of way and maintenance of equipment conditions; improved yard and terminal facilities; operation of trains against current of traffic on multiple track lines; increased train loads; and very important, supervision and dispatching.

All of these also have considerable influence on the conditions of train operation.

Chairman W. M. Post:—I think the Committee has made it clear in this report that there are many other factors that enter into improved train operation. We have mentioned some of them and Mr. Teal has mentioned others. However, we do want to emphasize the fact that signals did contribute largely to it, and it is at least interesting that Group A has a higher gross ton miles per train hour than Group B, and Group B has a higher gross ton miles per train hour than Group C.

Vice-President J. V. Neubert:—Is there any other discussion? If not, the report will be received as information.

Chairman W. M. Post:—Appendix C, Progress Made in the Use of Modern Railway Signal Systems, appears on page 637, with a chart on page 638. Will you please refer to the chart? Item 1 is miles of road operated by Class I steam railways as of December 31, 1928. Item 2 is miles of road of 47 railways. These 47 railways have operating revenues above $25,000,000. Item 3 is miles of road, main line, of the 47 railways, excluding branches and lines of minor importance, on which it is recognized it will be a long time, if ever, before automatic signals will be justified. Item 4 is miles of road of the 47 railways equipped with automatic block signals as of December 31, 1929, totaling 53,717 miles. Item 5 is miles of road, Class I railways, equipped for train operation by signal indication on single track and in either direction on multiple track lines, including centralized traffic control system. That shows 2,185 miles of road. Item 6 is miles of road, Class I railways, equipped with automatic train stops or train control devices, 11,541 miles. Item 7 is miles of road, Class I railways, protected by visual cab signals. This item includes cab signals with automatic stops as well as signals with the whistle and acknowledger.

This is presented as information.

Vice-President J. V. Neubert:—Is there any question? If not, it will be so received.

Chairman W. M. Post:—Appendix D, Current Activities of the Signal Section During the Past Year, can be found on page 639.

The Committee presents a list of twenty reports which can be found in the Signal Section literature. I might call a few of these to your attention as they may be particularly interesting to the members.

1. Train operation by signal indication.
2. Consolidation of interlockings.
4. Operating results obtained by use of automatic block signals replacing manual block on 58.3 miles double track line.
6. Installation of car retarder system.
7. Signal protection of spring switches.
8. Centralized traffic control system.
14. Five reports on highway crossing protection.

We have listed the specifications revised and new specifications. This is also presented as information.

Vice-President J. V. Neubert:—Are there any questions? If not, it will be so received.

Mr. H. M. Stout (Northern Pacific):—I should like to ask the Chairman of the Committee if he is able to state approximately the signal situation of the United States as a whole, that is, are the railroads as a whole completely signaled, 60 per cent, or what per cent?

Chairman W. M. Post:—I am unable to state that offhand. The Committee will be very glad to look into that question and present it in their next report.

Mr. H. M. Stout:—It is not of any importance, of course, just as a matter of interest.

Chairman W. M. Post:—I haven't the data in front of me.

Vice-President J. V. Neubert:—I feel that the Committee has made a very, very excellent report. It has covered three subjects contained on page 627, development of automatic control, improvement of operation, progress made, and so forth. I believe this Committee feels that they have not acknowledged all the improvements in regard to the efficiency in operation, but they have contributed largely. I think that the improvement and development and the educational work that has been done by the Signal Section has retarded the building of more main tracks and possibly reducing the yardage and mileage at the terminal, because they can get more mass tonnage and movement.

However, I do feel that they have come very strongly in the alphabet of economics of railway transportation. I think their motto is "Lead Kindly By Lights." The Committee is excused with the thanks of the Association for their excellent report (Applause).

DISCUSSION ON RULES AND ORGANIZATION

(For Report, see pp. 135–149.)

(Vice-President J. V. Neubert in the chair.)

Mr. E. H. Barnhart (Baltimore & Ohio):—The report of the Rules and Organization Committee is shown in Bulletin 330, beginning at page 135.

The first subject, Revision of Manual, will be presented by Mr. Coons, the Chairman of the Sub-Committee.

Mr. P. D. Coons (Chicago, Burlington & Quincy):—The report of the Sub-Committee will be found on page 138 under Appendix A, in Bulletin 330.

The rules proposed, or modifications proposed, are of a precautionary nature. The first three are those pertaining to employees working on or about track.

There is a slight correction to be made to Rule 214. The first word should be plural and read "Sledges" instead of "Sledge." The balance of the rules on this page relates to employees working on the maintenance of buildings or structures.

Since the report was written we have received a suggested change or modification for Rule 171. The suggestion was received from Mr. S. S. Roberts of the Finance Bureau of the Interstate Commerce Commission. This

Committee and the Committee on Buildings have approved his recommended change. The revised rule now reads as follows:

"Rule 171. Employees must not climb on any ladder nor leave any ladder standing until it is secured against slipping. Employees must use a safety belt and rope when working outside of windows or on steep roofs."

These rules are offered for inclusion in the Manual, and I so move their adoption.

Vice-President J. V. Neubert:—Is there any discussion on these rules, or any remarks? All in favor please say "aye"; contrary, "no." It is carried.

Chairman E H. Barnhart.—The first part of the second subject assigned to the Committee is shown in Appendix B, covering rules for maintenance of wooden structures, and will be presented by Mr. Griggs, the Chairman of the Sub-Committee.

Mr. A B. Griggs (Atchison, Topeka & Santa Fe)·—The report of the Sub-Committee appears on pages 139 and 140 of Bulletin 330, under Appendix B.

As stated on page 136, the Committee offers for approval and printing in the Manual, Rules 1200 to 1220, inclusive, shown in Appendix B—Rules for Maintenance of Bridges—Wooden Structures. These rules have the approval of Committee VII—Wooden Bridges and Trestles.

These rules were reported to the convention last year in their present form, and since the printing in the present Bulletin there have been some comments and suggested changes in phraseology, without changing the meaning or subject matter. The Sub-Committee has given these consideration but feels that since the rules as they stand have been before the convention and the Association since the meeting of last year, and have the approval of Committee VII, they should be approved as written.

I move that they be approved for inclusion in the Manual as recommended practice.

Vice-President J. V. Neubert:—It has been moved and seconded that these rules be included in the Manual. Are there any questions? If not, all in favor please say "aye"; contrary, "no." The motion is carried.

Chairman E. H. Barnhart:—The second portion of the second subject assigned to the Committee covers the rules for terminal structures other than buildings. The report is found in Appendix C, page 140, and will be presented by Mr. Kulp, Chairman of the Sub-Committee.

Mr. B. R Kulp (Chicago & Northwestern):—The rules as worked up and reported on by the Sub-Committee for maintenance of other terminal structures are found on pages 140 and 141.

Rules for guidance of employees on maintenance of oil houses, coaling stations, cinder pits and turntables have appeared in the Proceedings of two previous years as information. They have been gone over with various sub-committees. They have the approval of Committees VI—Buildings, XIV—Yards and Terminals, and XXII—Shops and Locomotive Terminals.

The rules pertaining to track scales, 1290 to 1297, have been worked up in collaboration with the Sub-Committee of Yards and Terminals and is for the first time appearing in this form.

There has been but one criticism received on these rules, which was received from Mr. S. S. Roberts by correspondence, pertaining to Rule 1292 which reads as follows: "Scale parts must be kept clean and free from inter-

ference." He felt as though the rule should be enlarged upon so as to differentiate the meaning of interference, whether it pertained to interference of employees other than employees of the scale department, or whether it pertained to interference of parts of the scale.

This rule, in the preparation of it, was discussed along those lines very thoroughly with the Sub-Committee of Yards and Terminals, and it was the consensus of the Sub-Committee to get the rules as brief as possible. We felt as though the rule in its present form referred to interference of any kind whatsoever. I so notified Mr. Roberts, but up to the present he has not had time to reply.

But the Committee of Rules and Organization as a whole discussed it and felt as though it should stand as printed. Therefore, I recommend that the rules be approved by the Association and included in the Manual.

Vice-President J. V. Neubert:—Are there any questions?

Mr. W. P. Wiltsee (Norfolk & Western):—There are one or two points on this report that I should like to bring out. I notice that under oil houses reference is made to the fact that oil storage facilities must be kept thoroughly grounded at all times. I do not think we can emphasize that too much. The more we learn of stray currents, the more necessary I feel that precaution should be taken.

There is one item under turntables that I do not see covered. Sometimes it is the practice of an engine house foreman to disconnect the driving wheels and probably take out one or two of them, and then have the engine moved to another stall, or for some reason taken out on the turntable, and in that way concentrate the loads on a few axles, which produces too great a stress in some of the members of the turntables, eventually ruining it. I would suggest that the Committee consider a rule forbidding that practice in a future report.

Vice-President J. V. Neubert:—The Committee on Outline of Work will be very glad to take that into consideration.

Is Mr. Harrison of the Pennsylvania here?

Mr. M. J. J. Harrison (Pennsylvania):—In connection with the rules proposed by the Committee for application to track scales, I should like to say as a member of the collaborating committee that the rules have the unanimous approval of that committee. I am glad to join in Mr. Kulp's recommendation that they be approved as printed in the Bulletin.

Vice-President J. V. Neubert:—Any other questions? All in favor say "aye"; contrary, "no." It is carried.

Chairman E. H. Barnhart:—The last subdivision of the general Subject (2) covers the maintenance of telegraph and telephone lines and appurtenances, collaborating with Telegraph and Telephone Section, A.R.A.

This subject is one which has been before this Committee for two or three years, and on page 136, is given the status of the present situation. I hardly think it is necessary to read it.

The third general subject assigned to the Committee is to recommend titles employed to designate positions of corresponding rank in maintenance of way service, subordinate to that of Division Engineer. The report is shown in Appendix D on page 142 and will be presented by Mr. Brooke, the Chairman of the Sub-Committee.

Mr. Richard Brooke (Chesapeake & Ohio):—A summary of replies to questionnaire sent to a number of representative railways of the United States and Canada is shown in Appendix D. While some of the titles are not employed on a number of the railways, they are either employed on a large majority of those replying to the questionnaire or more commonly used than equivalent titles of corresponding rank. A number of these titles have been in general use by this Association in the past.

The titles have been listed under two general headings:

"First, Assistant Engineers—Maintenance of Way Department.

"(1) Assistant Division Engineer—Engineer who reports to the Division Engineer, supervises general maintenance work and acts for the Division Engineer in his absence.

"(2) Assistant Engineer, Maintenance—Engineer who reports to the Division Engineer, is responsible for the preparation of plans and estimates and supervises field and office engineering work.

"Second, Foremen—Maintenance of Way Department.

"(1) General Foreman—Supervisory officer responsible for the maintenance and construction of track on an assigned territory or assigned project.

"(2) Section Foreman—Foreman responsible for the maintenance of track, roadbed and right of way on a designated territory.

"(3) Extra Gang Foreman—Foreman of a floating gang engaged in laying rail, applying ballast or other track or roadway work usually requiring a larger organization than a section gang.

"(4) Work Train Foreman—Foreman in general charge of a work train and a gang handling material and doing other work performed with a work train.

"(5) Welder Foreman—Foreman in charge of building up rail ends, frogs and switches in and along the track.

"(6) General Foreman, Bridges and Buildings—Supervisory officer responsible for the maintenance and construction of bridges and buildings on an assigned territory.

"(7) Bridge and Building Foreman—Foreman in charge of maintenance and construction of bridges and buildings.

"(8) Mason Foreman—Foreman in charge of maintenance and construction of masonry.

"(9) Painter Foreman—Foreman in charge of the painting of bridges and buildings.

"(10) Plumber Foreman—Foreman in charge of maintenance and construction of plumbing.

"(11) Tinner Foreman—Foreman in charge of sheet metal work.

"(12) Fence Foreman—Foreman in charge of maintenance and construction of fences.

"(13) Water Service Foreman—Foreman in charge of maintenance and construction of water service facilities.

"(14) Signal Foreman—Foreman in charge of maintenance and construction of signals and interlocking."

It is the sense of the Committee that these are the proper titles to designate positions of corresponding rank in maintenance of way service and to promote uniformity in nomenclature. Since the report was printed we have received criticism by letter from two members of the Association pertaining to the titles Water Station Foreman and Signal Foreman. These are being considered and we would be glad to receive criticisms or suggestions from other members as they will be helpful to us in arriving at a definite recommendation for next year's report.

I move that this report be received as information.

Vice-President J. V. Neubert:—Any discussion? Any remarks? If there are none, it will be so received.

Chairman E. H. Barnhart:—The material given in Appendix D is what this Committee considers a very important assignment, and as suggested by Mr. Brooke, we would certainly like to receive more than two criticisms or suggestions in so far as they pertain to the titles used in the maintenance of way department to preserve uniformity of nomenclature.

The fourth general subject assigned to the Committee covers rules for fire prevention as applying to the maintenance of way department, collaborating with the Railway Fire Protective Association.

The Sub-Committee in charge of this work has done considerable work during the year, but is not in position at this time to present a report. We are hoping to get sufficient information together and get far enough along with the collaboration with the Railway Fire Protective Association so that next year we can give you something, at least as information.

The fifth subject was a new one last year and has to do with the question of registration of engineers, architects and surveyors.

Last year Mr. Warden, who is Chairman of this Sub-Committee, and also connected with one of the state boards of engineering examiners, presented a very constructive and informative report on the progress made along this line. This work has been continued by Mr. Warden, and we present in Appendix E, page 143, for the information of the members of the Association, a proposed bill for introduction into state legislatures and general assemblies, to create an act to regulate the practicing of professional engineering, land surveying and architects in the state.

This bill has been drawn with the co-operation of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Society of Electrical Engineers, the American Association of Engineers, and others, and has been approved by a number of engineering societies which are listed on page 137.

I might state that in going over this matter with the representatives of the various national societies, we of course suggested several minor changes, but such changes were not accepted and the proposed bill is given as it has been drawn by the several societies which sponsored it.

This is simply given as information, and in accordance with your instructions, we will continue to follow up this matter and present to the Association each year the progress being made along this line.

Vice-President J. V. Neubert:—Is there any discussion or remarks? If not, it will be so received.

I do not believe any railroad can exist unless it has an organization. I do not believe the organization can function unless it has some rules for regulation, because there are a great many problems in regard to the application and use and efficiency in transportation. The Committee is excused for their excellent report with the thanks of the Association (Applause).

DISCUSSION ON RECORDS AND ACCOUNTS

(For Report, see pp. 501–546.)

Mr. C. C. Haire (Illinois Central):—The Committee's report is in Bulletin 333, page 501.

We have fourteen assignments covering the subject of accounting as it affects maintenance, construction, engineering, valuation, impending changes in the accounting classification and depreciation accounting, as well as a number of subjects of a general nature.

The first assignment we have is Revision of the Manual. The Committee has nothing to report this year, but we are reviewing the material in the Manual with a view to developing new matters to make the subject of Records and Accounts complete.

The second subject of the Committee is changes or revisions in the I.C.C. classification of accounts. There has been no development in this assignment this year, so the Committee has nothing to report except that we are watching developments so as to be in position to make report next year.

Our next subject, (3), appears on page 503, and is one covering valuation. Mr. Bertenshaw, Chairman of the Sub-Committee, will present the report.

Mr. B. A. Bertenshaw (Cleveland, Cincinnati, Chicago & St. Louis):—The report of this Sub-Committee is in five sections, the first of which consists of definitions of terms. There are sixty-one definitions to be found on pages 503 to 506 in Bulletin 333. All of these definitions, with the exception of two, "Index Number" and "Price Trend", have been before the convention previously and may be found in the Proceedings, Volume 29.

The Committee recommends that these definitions be included in the Manual, and I so move.

The President:—It has been moved and seconded, gentlemen, that the definitions appearing on pages 503 to the top of 506 be adopted for printing in the Manual. Definitions such as these are not subject to discussion on the floor, but the Committee always appreciates any suggestions concerning them.

(The motion was put to a vote and carried.)

Mr. B. A. Bertenshaw:—The next section is an outline of the methods and forms for bringing land valuations to a later date or dates, and this is an outline of what is required by the Interstate Commerce Commission as outlined in their plan, together with suggested forms for gathering the necessary data in the field, and the assembling and summarizing of this data in the office. The method outlined here follows generally that used by those railroads which have made a re-appraisal of their land subsequent to valuation date.

The third section presents some new forms. On page 724 of the Manual there was a form for Roadway Completion Report, but Supplement No. 5 to Valuation Order No. 3, calls for some information that was not provided for on that form. The Committee has therefore designed a new form, the principal difference being that the new form will separate property retired into that included in the engineering report, and that installed subsequent to the date of valuation.

There are also two new forms submitted, one covering roadway machines and the other shop machinery, both of which are intended to collect the information required by Supplement No. 5 to Valuation Order No. 3.

The next topic is the use of price trends. The fluctuation of prices since the war has made it difficult to estimate the value of railroad property at any given date on account of the lack of sufficient cost data on all of the almost innumerable items that go to make up the property, and the Committee has undertaken to show how price trends may be advantageously used for estimating the cost of items or groups of items after the trend or index numbers have been worked out.

The last subject is that of the simplified method for reporting Account No. 10, Other Track Material. Because of the number of items included in this account, the work involved in the reporting and recording is out of proportion to the amount of money involved, and the Committee has undertaken to work out some scheme whereby the amount of work will be very materially reduced. That study has not gone far enough to make any report this year, but will be continued next year.

These latter subjects are for information only.

The President:—Is there any discussion of these subjects? If not, they will be so received.

Chairman C. C. Haire:—The fourth assignment of the Committee covers depreciation accounting. I will ask Mr. Kettenring, Chairman of the Sub-Committee, to present the progress report of the subject.

Mr. W. R. Kettenring (Chicago & Northwestern):—While we have had many rumors on the subject of depreciation accounting in the last year, there has been no public development since the published report of Commissioner Eastman in November, 1929, and the appearance of counsel for the President's Conference Committee in answer to that report. The Committee has maintained a working organization in anticipation of the publication of a final report on depreciation.

Chairman C. C. Haire:—The fifth assignment of the Committee will be found on page 520 of the Bulletin. This is a new assignment, and we consider it a very important one.

During the latter part of last year this question was made more prominent by the Association of Railway Executives delegating the Railway Accounting Officers Association to look into this subject. We expect to continue the work and collaborate with the Railway Accounting Officers Association. Mr. Sharood, Chairman of the Sub-Committee, will present the report.

Mr. F. C. Sharood (Northern Pacific):—The subject covered by this report is one which has been discussed formally and informally for about fourteen years, and it remained for this Committee to have the temerity to attempt to put it in formal shape.

The report this year covers only a recital of the requirements of the various bureaus of the Commission, and a suggestion that the Committee be permitted to receive the suggestions of the other members of this Association, the Committee recognizing that there are many angles to the subject and it is one that requires the best thought of all the members of the Association.

The Committee attempted to work out a plan which met with practically the unanimous approval of the Sub-Committee, but we found that we had failed, unintentionally probably, to take into consideration the views of many other members of the Association not represented in the Committee, and also the views of the Railway Accounting Officers Association, and the views of various representatives of the Presidents' Conference Committee.

We therefore feel that we should be allowed to continue this subject for this year, and we also feel that we should receive from you gentlemen and members of the Association who are interested in this subject and are responsible to a large extent for some of the expenditures necessary to carry on this work, suggestions as to how we can co-ordinate and simplify the various records which we are, under governmental regulation, compelled to keep. I therefore ask that the Committee be allowed to continue the subject and that the Association be requested to furnish suggestions.

The President:—The Chairman of this Sub-Committee requests that this subject be continued and that the members of the Association furnish the Committee with all the information they can regarding the subject. Is there any discussion? If not, it is so ordered.

Chairman C. C. Haire:—The sixth assignment to the Committee was: Statistical requirements of the accounting, operating or other departments with respect to maintenance of way and structures, collaborating with appropriate committees.

The Committee reports progress this year as we wish to collaborate with several other committees. This has not been perfected as yet.

The seventh subject covers: Forms used by railway water service departments, collaborating with Committee XIII—Water Service and Sanitation. It appears under Appendix D. Mr. D. C. Teal, Chairman of the Sub-Committee, will present the report.

Mr. D. C. Teal (Chesapeake & Ohio):—Sub-Committee No. 7's report appears in Bulletin 333, page 523, and covers the assignment: Forms used by railway water service departments, collaborating with Committee XIII—Water Service and Sanitation.

In the pursuance of this assignment the Sub-Committee prepared and submitted a questionnaire to all of the leading carriers of the country and received replies with copies of current water supply department forms from twenty of these railroads. The questionnaire developed practices ranging from very simple reporting methods to intensely developed systems of reporting and recording the cost of producing and treating water. Analyzation and study of the forms used resulted in a general classification from which the Sub-Committee selected the record of cost of water production as the most important. The Sub-Committee has endeavored to design a form for this record suitable to present-day water service requirements. Direct contact has been effected with Mr. H. E. Silcox, collaborating member of Committee XIII and the present form as shown on page 324 has the approval of his committee.

The Sub-Committee presents this report as information with the understanding that the form shown is to be recommended for inclusion in the Manual at a later date, along with the other water supply department forms that have not yet been developed.

The President:—That report is submitted for information. Is there any discussion? If not, it is so received.

Chairman C. C. Haire:—The eighth assignment was: Accounting for industry tracks in its relation to ownership and contract provisions, collaborating with Committee XX—Uniform General Contract Forms.

Previously this Sub-Committee had submitted a complete report for the information of the Association, and the report this year is a slight modification of what previously has been published.

It is nothing more than a progress report and is submitted for information The Committee desires to continue the subject, however, because it feels that it should collaborate with Committee XX before the subject is concluded.

The report is submitted as information.

The President:—It will be so received.

Chairman C. C. Haire:—The assignment which was given to the Committee under (b) of the ninth assignment, covering annual reports of grade crossings, is listed on page 502. Considerable work has been done by the Sub-Committee assigned to the subject, but at the beginning of the year it was the understanding that we would wait until Committee IX had developed their classification of railway-highway grade crossings, after which we would take up the subject.

The next subject is (10), Methods and forms for maintaining a record of changes in jointly owned interlocking plants, with respect to ownership and contract provisions, collaborating with Committee X—Signals and Interlocking.

We have a progress report which will be submitted by Mr. Weymouth, Chairman of the Sub-Committee.

Mr. A. P. Weymouth (Pennsylvania):—Mr. President, this report is on page 526 of Bulletin 333, and is a new assignment this year. It deals with the methods and forms for maintaining records of changes in jointly owned interlocking plants.

In the past it has been found that a large percentage of the contracts covering such plants were silent on ownership. In the valuation of the railroads certain complications arose, also in regard to changes made in physical properties since the date of valuation.

In the matter of existing contracts, where there are contracts, of course the provisions must hold as regards ownership, and it is felt that it is very desirable in such contracts that the method of ownership should be stated definitely.

In regard to keeping the record of changes, various methods may be used, as shown in the report, such as the investment method, and the method of using adjustment unit values, in this way keeping track of the changing percentages of ownership due to alterations by one or more carriers in the joint plants.

There is also the price trend method and the method used by the signal engineers on a functional unit basis.

As this is a new assignment this year, the report is simply submitted as information.

The President:—If there is no discussion it will be so received.

Chairman C. C. Haire:—Subject 11, reported upon by the Committee, is a very interesting report on the use of mechanical devices for accounting. Mr. Powers, Chairman of the Sub-Committee, will make a few remarks.

Mr. John T. Powers (Eastern Group, Presidents' Conference Committee):—The report of this Sub-Committee begins on page 528 and extends to page 535. We have undertaken to briefly describe various types of machines used in offices, particularly the punched card accounting machine. Detailed report of that begins on page 531. We also describe bookkeeping machines of the cylinder type and the flat writing type.

Our conclusions are reported on page 535, which briefly are that before one can decide what kind of an installation in an office should be made, the

volume of the work should be very carefully studied. That, I think, is about all we have to report except that the report was made as a matter of information, and we recommend that the subject be discontinued.

The President:—Is there any discussion? This is very interesting information submitted by this Sub-Committee. If there is no discussion, it will be so received, and the Committee on Outline of Work will take note of the Committee's recommendation.

Chairman C. C. Haire:—Assignment 12 will be presented by Mr. Mead, Chairman of the Sub-Committee.

Mr. W. T. Mead (Illinois Central):—The report of this Sub-Committee will be found in Appendix H on page 536 of Bulletin 333. The report was prepared in the same manner as last year and is offered to the Association as information.

The President:—It will be so received.

Chairman C. C. Haire:—The next subject, No. 13, covers bridge inspection report forms. Mr. Mead also is Chairman of that Sub-Committee.

Mr. W. T. Mead:—The report of this Sub-Committee will be found as Appendix I on page 537 of Bulletin 333. This subject has been an assignment of Committee XI for several years. This year the Sub-Committee obtained sample forms from representative railroads, and have prepared three forms for bridge inspection which are presented as information.

We were asked to collaborate with four other committees. It must be admitted that this collaboration has not as yet been fully accomplished. It seemed best, however, to present something this year instead of giving the inference that the Sub-Committee were inactive.

If any of you have any criticism of the forms we will be glad to receive it so that it can be considered by the Sub-Committee and also with the collaborating committees. Or if on further study of the forms any of you wish to offer suggestions in writing, I assure you that we will be glad to receive them.

This report is offered as information.

The President:—It will be so received.

Chairman C. C. Haire:—The last assignment of the Committee, No. 14, is a report on the subject of what is transpiring in the field of recapture.

Mr. Geyer, in the absence of Mr. Silliman, Chairman of the Sub-Committee, will present the report.

Mr. C. J. Geyer (Chesapeake & Ohio):—The report of this Sub-Committee is in Bulletin 333, on page 542, methods used in recapture proceedings.

Your Sub-Committee has kept in touch with the Bureau of Valuation activities through the Presidents' Conference Committee in Washington. Changes are rapidly taking place in the methods of handling this problem both with the Bureau and the carriers. Further legal decisions may greatly modify the present procedure.

The recommendation of the Interstate Commerce Commission has been made to Congress to change this portion of the Transportation Act. At the time this report was made, Congress had taken no action, and, of course, we know they have taken no action since.

On the following several pages, 542 to 546, there is a brief of the things that have transpired in these proceedings up to the time that this report was printed.

This is submitted as information only.

The President:—It will be so received.

Chairman C. C. Haire:—That concludes the Committee's report.

The President:—This concludes the Committee's report, and it is relieved with the thanks of the Association (Applause).

DISCUSSION ON MASONRY

(For Report. see pp. 325–344.)

Mr. C. P. Richardson (Chicago, Rock Island and Pacific):—The report of the Committee on Masonry will be found in Bulletin 332, on pages 325 to 334. The Committee reports on six subjects: Revision of the Manual; principles of design of plain and reinforced concrete; science and art of concrete manufacture; contact with the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete; waterproofing masonry structures; repair of deteriorating concrete.

I wish to say, however, as there is no action required by the Association on the last four named subjects, they will be referred to by subjects only unless discussion is desired from the floor.

The first section of the report deals with the revision of the Manual. I will ask Mr. Leonard, Chairman of the Sub-Committee, to present this report.

Mr. J. F. Leonard (Pennsylvania):—The revision of the Manual as presented at this time is entirely a matter of bringing our specification on Portland Cement and the testing of Portland Cement up to date in accordance with the A.S.T.M. specification.

In the report as presented here, there is on page 330 a change to Article 11, to the new Article 11, as you will see, by rounding off the dimensions of the reinforced bars in accordance with the recommended change of the American Standards Association. It is merely the dropping of the third decimal and showing the sizes in two decimals only.

I move the adoption of the report.

The President:—This motion carries with it the adoption of the revised specifications for printing in the Manual. Is there any discussion?

Mr. J. B. Hunley (Cleveland, Cincinnati, Chicago & St. Louis):—In the proposed revision of Article 3, for the fine aggregate, they have changed the percentage passing through No. 4 sieve from 100 per cent to 95 per cent. That, of course, is desirable. But the grading then jumps to the next size of sieve, No. 50. It specifies that not more than 30 per cent shall pass through a No. 50 sieve. That means, of course, that 70 per cent must be retained on the No. 50 sieve, but in very many pits, the particles are but slightly larger than the No. 50 sieve and this will result in a very fine sand and probably a poorly graded sand.

It has always been my thought it would be much better to include in the grading another sieve, say a 16 sieve.

With this present specification, it is entirely possible to get a sand which will have a density of only about 60 per cent. If a coarse sieve were included,

say a No. 16, and limit the minimum to about 30 per cent or maximum of 80 per cent, it is quite possible to get a sand having a density of 70 per cent or even higher. That is quite important where concrete is proportionated by volume, or the aggregate is purchased by volume. It will also be very desirable if you were using the sand with a poorly graded coarse aggregate, that is, a coarse aggregate deficient in fine particles.

In the revision of Article 17, the 1500 lb. concrete or the 8 gallon water per sack of cement, has been eliminated. I believe there is no one more enthusiastic about dense concretes than I am. But there is a place for 1500 lb. concrete and that is in the footings. It is not exposed to the weather. It has proven uniform in strength and quality by field tests and we get mysteriously high strengths with this 1500 lb. concrete. I think the excess over the required strength is probably higher in that class than any other that we use. Fifteen hundred lb. concrete probably requires three-quarters of a sack less per yard than Class 2000.

I would much prefer to save that, take it out of the footing and put in better concrete above the footings, where it is exposed to the weather. I think we will still find many uses for Class 1500 lb. concrete. It should not be used at all where it is subject to exposure or deterioration, but it can be used advantageously in other places.

I think the change in Article 24, time of mixing from one minute to one minute and one-half, is very good.

Mr. B. R. Leffler (New York Central):—Referring to Article 17, in which the 1500 lb. concrete is eliminated, I am in accord with the Committee on that in that I think they have taken a step in the right direction. I do not think the step is quite big enough. I should like to see in these specifications a positive declaration to the effect that no more than a certain number of gallons of water shall be used per sack of cement for any concrete exposed to freezing and thawing. I regard that such a declaration is the most important declaration that can be made as the governing clause to insure good concrete.

We have been charmed a little bit too much by the water-cement ratio as a means of designating concrete for certain strength. We are coming around to a more important viewpoint, that is, permanency of the concrete. It has been demonstrated during the last four or five years by many laboratory tests made by various state highway departments as well as by the Portland Cement Association, that beyond a certain number of gallons of water per sack of cement, disintegration becomes very marked. That limit is between 6½ and 7 gallons.

I would like to see a clause inserted as a blanket statement in the proper place limiting the maximum amount of water per sack of cement for all concrete exposed to freezing action at 6½ gallons per sack. I think we have plenty of experimental data to warrant such a declaration.

As to the possibilities of making concrete under those conditions, in our own practice we are limiting the water to 6½ gallons per sack. You can make mass concrete with this amount of water and use no more than 5 sacks of cement to a cubic yard of concrete in place. I do not think any concrete exposed to disintegration should be built with less than 5 sacks of cement per yard of concrete in place. I think the Kansas State experiments show that is about the limit.

I make a motion to the effect that such a declaration be adopted and if ot adopted that the Committee be instructed to bring in a proper declaration ı the next report.

Mr. J. F. Leonard:—In connection with the remarks by Mr. Hunley and Mr. Leffler on the revision of the Manual, the first criticism of Mr. Hunley was n regard to the sizes of the sieves for the grading of the aggregate. The sec›nd was in regard to the elimination of 1500 lb. concrete. Mr. Leffler re-narked in regard to the question of the maximum amount of water.

In regard to the size of the sieves, it is my understanding that all specifications use just these size sieves. It is the feeling of the Committee that it is advisable to stick to that because that is the size used in standard practice.

In regard to the question of the elimination of 1500 lb. concrete, the Committee, I think, undoubtedly feels very strongly on the fact that with the present strength of Portland cement it would be most inadvisable to continue using 1500 lb. concrete under any circumstances. But in regard to that question and in regard to the question of the limit of the amount of water per sack of cement, I should like to refer both of these to Mr. Walter, who is Chairman of a Sub-Committee which really handles those subjects. I will ask Mr. Walter to make further answer.

Mr. L. W. Walter (Erie):—If those of you who have Bulletin 332 will refer to page 335 you will find outlined the problems of study for the ensuing year as delegated to Sub-Committee 3 on progress in the Science and Art of Concrete Manufacture. We are now concentrating on factors affecting durability. There are other factors affecting durability of concrete that are not included in this year's program for study. We think that the program is sufficiently broad to keep us busy even though it is not all inclusive. Although the report of Sub-Committee 3 was submitted for information only, I will refer to it and, with your permission, will read from it: "During the past year, the Sub-Committee has endeavored to maintain contact with various organizations and societies which, through special bureaus or committees, are organized to observe and study the performance of concrete structures in service and to carry on research work, the result of which gives promise of material aid in the solution of problems under way."

Members of this Sub-Committee have been instrumental in introducing some of our special problems as subjects for study by technical committees of other societies. Some have been taken up with Committee C-9 of the American Society for Testing Materials and some with the American Concrete Institute. The Committee, through our Association, has representation on the Joint Committee on Concrete and Reinforced Concrete and I understand the Joint Committee will give serious thought to factors affecting durability of concrete. Your Committee is organized, we think, to tune in on everything that is being broadcast on any wave-length.

Time was when we could, with more dependability than we can to-day, place confidence in strength of concrete at the 7 and 28 day periods as a measure of its enduring qualities.

In the manufacture of cements the tendency in recent years has been toward the stepping up of their strength-giving quality at the early periods. Present-day cements give higher strength results at 7 and 28 days than was characteristic of cements made 10, 12 and 15 years ago.

We know something of the performance of concrete under different conditions of exposure in structures made of the 1:2½:5 mix, requiring, with the average materials, about 5 bags and of the 1:2:4 mix, requiring with the average materials, about 6 bags of cement per cubic yard.

We are also familiar with the materials used, the construction methods and the manipulation of the concrete in many structures, some of which are disappointing.

It is the intent of your Committee to respect the water-cement ratio law, studying particularly what we would call the cement-water paste, the extent to which it is necessary to dilute this paste to give suitable workability to concrete with a given cement factor and the limit beyond which we must not go in attempting to economize in the use of cement.

So far as the protection of this Association goes, I do not feel that we are prepared to promulgate any fixed recommended practice at this time as to the class of concrete that is best suited to withstand various conditions of exposure. It is important, however, that we reverse our former views and, instead of designing for strength, design concrete first for durability. If the strength is not then sufficient to meet the strength requirement, as such, we must increase the cement content, and lower the water-cement ratio sufficiently to secure the required additional strength. We will then have durability plus rather than strength minus.

I believe your Committee can work out these problems, and I hope that we will by next year be able to submit definite recommendations and give you the best information available, based on what is considered the best recommended practice, as we get the recommendations from seemingly the best sources; from those who are best qualified from the standpoint of experience, and with facilities for investigation and research. So if you will bear with the Committee for one year, we expect to give you something quite worth while. If by that time we are not able to do so, we will be sadly disappointed. I think we will be able to do what we hope to do.

Mr. J. B. Hunley:—I should like to correct an impression apparently left by my former remarks, that is, that I would think of using this 1500 lb. or 8 gallon concrete, in exposed service. That is not my idea at all. I agree with Mr. Leffler that concrete for exposure should even be better than the 7 gallons per sack of cement. I am not particular about the strength. Any concrete that is built with a reasonable cement-water ratio would have sufficient strength. For higher strength, such as the 3500 lb. class, you have so little water that you are assured of density and durability, if the aggregates are sound. I would not advocate that 1500 lb. concrete be used in exposed work. If it is included, I think it would be well to limit its use by a statement to the effect that it may be used only where it is not exposed to the weather.

All I had in mind was that in many places it can be used, and what saving there is in cement can be used to better advantage in the next class of concrete, and perhaps cut that down to 6½ gallons per sack.

As to the question of fine aggregates, this range of sieves, so far as I know, first appeared in the Joint Specifications for Concrete. In our laboratory we made a great many tests on sands of different gradings, and we found we got very poorly graded sand of very low density with just such a specification. We found it quite necessary in our specification to put in the next size sieve, the No. 16 sieve, to get dense sand.

Mr. W. P. Wiltsee (Norfolk & Western):—It is not entirely clear to me just what the Committee is recommending. They start off with specifications for Portland cement, with no division between pages 329 and 330. They get into specifications for concrete. Has any action been taken on their recommendation for specifications for Portland cement? That, I understand, they are recommending to be printed in the Manual. If I understand the discussion which has been on concrete, they are submitting that as information only.

Mr. J. F. Leonard:—In reply to that, it is a recommendation that everything which is in this report is in the form of revisions to the Manual.

Perhaps, if the Chairman so agrees, the simplest way to bring the entire matter to a head would be to move the adoption in parts instead of in whole. Therefore, I move that the Association adopt the revision in present Article 6 of the Manual as shown in the report; the addition of proposed Article 16 as shown in the report; the addition of the proposed note to Article 28; the revision in Article 31 as shown in the report; the proposed addition to Article 33 as shown in the report; the proposed addition to Article 35 as shown in the report; the proposed addition to Article 45 as shown in the report; the proposed addition to Article 47 as shown in the report; the proposed revision to Article 52, the proposed addition to Article 56, and also due to the inclusion of new Article 16, all numbers 16 to 57, inclusive, be renumbered 17 to 58, inclusive.

That covers the question of the changes in specifications for cement and for the testing of Portland cement.

Then, if the Chair so agrees, after the vote is made on those I should like to make a motion in turn in regard to these questions which have been under debate on the floor.

The President:—Does that satisfy you, Mr. Wiltsee?

Mr. W. P. Wiltsee:—Yes.

Dr. A. N. Talbot (University of Illinois):—I should like to know if that carries with it the changes in the report (revision of recommended practice). On page 325, under "Action Recommended", No. 1 is "That the changes in the Manual in Appendix A be approved and that the complete Specifications for Portland Cement, as revised, be printed in the current supplement to the Manual." On page 327 the heading is "Specifications for Portland Cement". Then in the next paragraph below: "The proposed revisions of the present recommended practice are as follows". Could we not have a heading in Appendix A for the Proceedings that would indicate that Appendix A covers more than the matter of Portland Cement and includes such matters as reinforcing bars, aggregate and the mixing of concrete. Does the recommendation No. 1 include only Specifications for Portland Cement or is it intended to include the additional matters?

Mr. J. F. Leonard:—In answer to Professor Talbot's criticism, I would say that in editing the report we did neglect to make that distinction, and it is our purpose to make the distinction in printing in the Manual.

The President:—Is there any further discussion? Your motion is a substitute for your first motion?

Mr. J. F. Leonard:—I withdraw the first motion and I make the second motion, which is in regard to the particular article revisions which I have read.

The President:—The question is on the substitute motion. Is there any further discussion? If not, those in favor will please say "aye"; contrary, "no." It is carried.

Mr. J. F. Leonard:—The next item is the proposed revision in Article 3 of the Manual which changes the percentage passing through the No. 4 sieve from 100 to 95 per cent, and makes no other change.

I move the adoption of the revision as shown on page 330.

Mr. W. P. Wiltsee:—I should like to ask if these recommendations are in accord with the Joint Specification for Portland Cement and Concrete of the various associations.

Mr. J. F. Leonard:—We are trying to co-ordinate our Manual with the specifications of other associations. Of course, the Joint Committee report is now about six years old, and a new Joint Committee is now starting on this very same subject.

I can not advise you, without looking the matter up further, as to whether this agrees with the old Joint Committee report or not, but I believe it does agree with a number of other practices as they have been brought up to date.

The President:—You have heard the motion, gentlemen. Is there any further discussion? If not, those in favor will please say "aye"; contrary, "no." Those in favor of the question will please raise their hands; those opposed will please raise their hands. The motion is carried.

Mr. J. F. Leonard:—I move adoption of the revision in Article 11, which is merely the reduction of the areas to two decimals instead of three, to agree with the Standards Association's recommendation.

I want to draw attention to the fact that in the revision we still left in the third decimal, although we made it a zero in each case, and it is the intention in the publication of the Manual to leave that zero out.

The President:—You have heard the question, gentlemen. Is there any further discussion? If not, those in favor will please say, "aye." Opposed, "no." It is carried.

Mr. J. F. Leonard:—I move adoption of the recommended revision in Article 17, as shown on page 331.

Mr. H. C. Crowell (Pennsylvania):—I think Mr. Hunley has the best of the argument. There certainly are some places where 1500-lb. concrete can be used, and for the Committee to bring in a report which states either directly or by inference that 1500-lb. concrete must not be used anywhere, I think is wrong. I fear we are losing sight of the old definition of an Engineer.

Mr. B. R. Leffler:—I think this can easily be taken care of by a qualifying clause to the effect that concrete of the qualifications named should be concrete exposed to freezing action. I am satisfied with Article 17 as revised, in view of the remarks made by the Sub-Committee Chairman to the effect that the Committee will bring in next year a positive declaration on the maximum amount of water to be used, which I hope will be six and one-half gallons.

Mr. H. C. Crowell:—If we are going to have further revisions in the Manual next year, why should we hurry to make this change this year, especially in view of the fact that it was not particularly called to our attention in the program of the Committee or by any sub-heads or in any other fashion? I think it may have been overlooked by a great many of us.

Mr. M. Hirschthal:—I think the gentlemen are exaggerating the value of the 1500-lb. concrete. The difficulty of getting concrete of the durability and

of its required strength is not in the concrete that goes into the mass. You do not have any difficulty with contractors putting too much water in that type of concrete. If you tested that concrete as thoroughly as you do the reinforced concrete, on which so much importance is placed, you will find that it runs considerably higher than you figured on. It has been my experience that the contractor will use 5½ gallons of water per bag of cement in mass concrete. It is only with the reinforced concrete that we have difficulty, and the 1500-lb. concrete has no place in the specifications, particularly in view of the fact that we have the high strength cements as now furnished by the cement companies.

Mr. J. B. Hunley:—If he is using 5½ gallons, he is not using class 1500-lb. concrete. We all know that the 1500-lb. concrete is stronger than is necessary in footing courses.

As I said before, I am not especially interested in the strength, but I am interested in the durability. If we eliminate 1500-lb. concrete, as Mr. Leffler suggested, and simply say that these other classes apply to uses of concrete in exposed places, that is all right except it does imply that you should not use 1500-lb. concrete; and if 1500-lb. concrete is to be used by inference or otherwise, there should be some limit as to the amount of water used in such concrete.

The President:—Is there any further discussion. If not, the question is on the motion.

(The motion was put to a vote and lost.)

Mr. J. F. Leonard:—I would like to make this remark in connection with it, that I personally feel the Masonry Committee will make the same recommendation next year and keep on making it until it is adopted. We are in hopes that the Association will finally agree with us.

I move the adoption of the revision in Article 24 which changes the minimum time of mixing from one minute to one and one-half minutes.

The President:—Is there any discussion?

(The motion was put to a vote and carried.)

Chairman C. P. Richardson:—Although the time is short, I do want to make one comment in sympathy with Mr. Hunley's remarks. The insistance of the Committee for this change in the grading of the fine aggregate was due to the practical impossibility of any sand meeting the specification now in our Manual. In other words, we should have some leeway. I am glad Mr. Hunley brought up the other subject, and the Committee will be glad to give that consideration.

The second subject of the report this year is on the Principles of Design of Reinforced Concrete Arches and Transmission Poles, and I will ask Mr. Hirschthal to present this.

Mr. M. Hirschthal:—The Committee on Masonry, through its Design Committee, having completed the review of the specifications of the Joint Committee on Concrete and Reinforced Concrete, has now proceeded on the self-allotted task of providing a specification for the design of every type of concrete or reinforced concrete structure, and this year presents two items, one of which is that on the design of transmission poles, on page 334, Exhibit A, which it recommends for adoption for printing in the Manual, and the second,

that of the principles of design of arches of plain and reinforced concrete which is really a progress report giving the subject covered thus far with the hopes of completing the specification for next year.

I move for the adoption of Exhibit A, principles of design of concrete transmission poles, for inclusion in the Manual and printing as recommended practice.

The President:—You have heard the motion, gentlemen. Is there any discussion?

Mr. E. F. Cathers (Missouri Pacific):—I would like to inquire if Article 13 is supposed to take care of the snap load.

Mr. M. Hirschthal:—Yes.

The President:—Is there any further discussion?

(The motion was put to a vote and carried.)

Mr. M. Hirschthal:—The other subject is that of design of concrete arches, which is presented as information, with the only correction that on page 333 the parenthesis for the formula for impact should be omitted as not necessary.

This is presented as information only.

The President:—It will be so received.

Chairman C. P. Richardson.—The Committee makes progress reports on the remaining four subjects listed on page 325, and unless there is some discussion desired from the floor we will not refer to these reports, and I will move they be received as information.

The President:—If there are no questions to be asked or discussion on these subjects, they will be so received. It is so ordered.

Chairman C. P. Richardson:—That concludes our report.

The President:—The Committee is excused with the thanks of the Association for this excellent report (Applause).

DISCUSSION ON RIVERS AND HARBORS

(For Report, see pp. 607–626.)

Mr. E. A. Hadley (Missouri Pacific):—Our Committee is divided into two sections, one on Rivers, of which I am Chairman, and the other on Harbors, of which Mr. Kirkbride is the Chairman, but who is not present.

In order to conserve time I will call on only one of the Chairmen of the Sub-Committees to present report of that Committee, and I will give the balance myself.

We were assigned twelve subjects. The first is that of Definitions of Terms. I will call on Mr. W. C. Swartout, Chairman of the Sub-Committee, to present that report.

Mr. W. C. Swartout (Missouri Pacific):—In presenting the definitions of terms on rivers and harbors work, we have attempted to include only those terms which are in general use. The meaning which has been given is that as understood in the region where the term is in most general use. While a great deal of very earnest thought has been given, it is appreciated that there may be suggestions or criticism, which I can assure you will be welcomed by the Committee.

Recognizing the appropriateness of the rule of the Association that definitions are not subject to debate, we are presenting these as information at the present time, to be revised as may be found desirable during the ensuing year, and to be offered for adoption at next year's convention. They are, therefore, something for the membership to shoot at and we are hoping that there may be very general target practice, both as to phraseology and of additional words or terms which you think should be defined by this Committee as applicable to the work included in rivers and harbors construction and maintenance.

We are in receipt of one such criticism from Mr. E. E. R. Tratman, Western Editor of Engineering News-Record, to which we will give very serious consideration, and we earnestly hope that there may be many other such criticisms.

The President:—This information will be so received.

Vice-Chairman E. A. Hadley:—On the second and third subjects, Methods for Protection Against River Bank Erosion, and Types of Construction for Levees and River Dikes for Flood Protection, the Committee recommends that these two subjects be continued open for further investigation and, as the art progresses, further reports be made.

The President:—They will be so received.

Vice-Chairman E. A. Hadley:—On Subject 4, Specifications Covering the Several Types of River Bank Protection and Levees in Common Use, the Committee recommends that specifications for levees submitted with last year's report as Appendix A-c be accepted and approved for printing in the Manual, and the specifications herewith submitted be accepted as information and the subject continued. I make that as a motion.

The President:—You have heard the motion. Is there any discussion?

(The motion was put to a vote and carried.)

Vice-Chairman E. A. Hadley:—Under the Harbors section of the work of this Committee, Subject 5 covers the various types of dredges and their respective uses. The report has been made covering this subject by the Sub-Committee under Appendix B-5, and I move that this report be approved and placed in the Manual.

The President:—It is moved and seconded that the matter contained in Appendix B-5 be approved for printing in the Manual.

(The motion was put to a vote and was carried.)

Vice-Chairman E. A. Hadley:—Under Subject 6, specifications for dredging have been presented by the Sub-Committee in Appendix B-6. I move that these specifications be approved and placed in the Manual.

(The motion was regularly seconded, put to a vote and carried.)

Vice-Chairman E. A. Hadley:—Subject 7, silt deposits in fresh water rivers at the meeting point with brackish waters and the effect of slight salinity on such deposits. There seems to be little information of any value on this subject. It is a generally accepted fact that salinity does affect deposits of silt, but to establish more information on this subject of any value to railroads would require a great deal of study, which the individual members of your Committee do not have time to give to the subject, and it is a question as to what real value it might be to the railroads in any event.

Under Subject 8, results of deepening channels on the salinity of rivers and estuaries, there is unquestionably a large amount of information on this subject published in various forms, much of it in foreign languages. It is beyond

the time of the individual members of the Committee to further develop that subject as it should be, and there is a further question as to the value of the results which might be secured for the railroads.

Therefore, your Committee recommends that these two subjects be dropped from our assignment.

The President:—I will ask the Committee on Assignment of Work to take note of that recommendation.

Vice-Chairman E. A. Hadley:—Subjects 9, 10 and 11 cover harbor structures of various types. The Sub-Committee, under Mr. Kirkbride, its Chairman, has collected a large amount of information and data bearing on these subjects but has been unable during the past year to give sufficient time and study to the information collected to make a comprehensive report. We therefore wish to report progress on those subjects and recommend a continuation of the subjects for report at the next convention.

The President:—They will be so received.

Vice-Chairman E. A. Hadley:—That concludes the report of the Rivers and Harbors Committee.

The President:—This Committee has made great progress in the assigned subjects and has submitted an excellent report. The Committee is relieved with the thanks of the Association (Applause).

DISCUSSION ON ECONOMICS OF RAILWAY LOCATION

(For Report, see pp. 221–234.)

Mr. F. R. Layng (Bessemer & Lake Erie):—The report will be found in Bulletin 331, page 221. I will ask Mr. F. E. Wynne, Chairman of Sub-Committee 1, to report on Appendix A.

Mr. F. E. Wynne (Westinghouse Electric & Manufacturing Company):—In Bulletin 331, on page 222 and succeeding pages, there is worked out a problem on the application of an electric locomotive merely as an illustration of how to apply the data which were furnished in last year's report. It is hoped that this specific problem will be of service to those who have need to work out an application of an electric locomotive.

Chairman F. R. Layng:—This is offered as information and I take it that it requires no further action.

The President:—If there is no discussion, it will be received as information.

Chairman F. R. Layng:—On Appendix B, I shall ask Mr. J. C. Wrenshall, Chairman of this Sub-Committee, to report the information.

Mr. J. C. Wrenshall (Reading Company):—The report of Sub-Committee 2, study and report on the extent train resistance is increased when trains are operating on flexible rails as compared with the same operation with stiffer rails, is found on page 231 of Bulletin 331. This report is in condensed form, and is intended as a progress report.

This is not a new subject, for as early as 1902 the late Dr. Dudley conducted tests of rails on the New York Central to ascertain practically the same information that this Committee has had assigned to it.

At the March, 1930, convention Chief Engineer A. N. Reece of the Kansas City Southern, presented a paper on "Economical Selection of Rail." Later on, in the report of the Roadway Committee, pages 221 to 231 of Volume 30, A.R.E.A. Proceedings, will be found a report by Mr. Paul Chipman, Office Engineer of the Pere Marquette Railway. Both of those papers have given information along the lines that we are endeavoring to solve.

The general opinion appears to be that better results are obtained from the use of more rigid rail, which seems to be coming into general use. It is recommended that this report be received as information, and the subject continued.

However, I now desire to say a few words concerning a matter not in this report. This Sub-Committee suffered a severe loss last year in the death of Mr. T. H. Lantry, General Manager of the Northern Pacific. Mr. Lantry was very well-known, especially through the Western section of the country. His fellow-committeemen were certain of three things concerning him: first, that he was a very willing worker, with all that implies; secondly, he was a contributor of reliable information; third, he was a splendid gentleman with all the attributes that go with that title. He will be greatly missed.

Chairman F. R. Layng:—The last subject reported on by the Committee is Appendix C, page 232, study and report on the proper size and character of field organizations for railway location and construction. The Committee in sending in this report to the Secretary recommended to the Association that it be received for approval and publication in the Manual. Since that time, however, we have been advised by the Committee on Rules and Organization that they wish to collaborate with us in this matter and have some suggestions to make. We therefore withdraw our recommendation that this be approved for publication in the Manual and we ask to have the subject reassigned so that we may carry out the proposed collaboration with the Committee of Rules and Organization. With your consent, we will ask to have this continued. We have nothing further to offer.

The President:—Is there any discussion on that part of the Committee's report? If not, it will be so received and the Committee on the Assignment of Work will take cognizance of the Committee's suggestion.

This Committee is excused with the thanks of the Association for its excellent work (Applause).

DISCUSSION ON ECONOMICS OF RAILWAY LABOR

(For Report, see pp. 193–204.)

Mr. F. M. Thomson (Missouri–Kansas–Texas):—In order not to take any more time than necessary, I will only call on a few of the Sub-Committee Chairmen in presenting their reports. Some of the Chairmen not being present, instead of calling on other members of the Sub-Committee, I will present their reports.

We have no revision of the Manual.

On Subjects 2, 5 and 7, the Sub-Committees have made good progress, but on account of reports not being complete, they were not printed this year and will be submitted during the next year.

The Sub-Committee handling Subject 2, analysis of operation of railways that have made marked progress in the reduction of labor required in maintenance of way work, have done some excellent work and we hope to give a report at the next convention.

Subject 3, effects of recent developments in maintenance of way practices on gang organization (such as use of heavier rail, treated ties, and labor-saving devices, which make practicable small section forces, and conducting the major part of maintenance work with extra gangs), Appendix A, pages 194 to 197, inclusive. Through personal correspondence with chief maintenance officers of twenty representative railroads, investigation was made as to the changes in gang organization. Quite a large number of railroads have made no change, and yet some have. Others have reduced the length of their sections.

On page 194 is a list of the railroads that have increased the length and decreased the number of sections; on page 195, summary of replies from railroads that have reduced track forces, on page 196, summary of replies from railroads that have transferred regular section work to extra gangs, on page 197 railways which report no effects on gang organization.

The Committee feels that this subject is a matter of importance at this time and the policy is changing toward the transferring of section work to specialized gangs equipped with modern labor-saving devices.

The conclusions reached are found on page 197:

"(1) Recent developments in maintenance of way practices such as the use of improved materials and labor-saving devices have reduced the amount of track labor required for adequate maintenance.

"(2) It is apparent that these developments in maintenance of way practices should permit the transferring of the heavier routine maintenance work from section gangs to specialized gangs equipped with modern labor-saving machinery with large resulting economy."

It is the recommendation that this report be received as information and the subject continued.

The President:—Is there any discussion, gentlemen? If not, it will be so received.

Chairman F. M. Thomson:—Subject 4, economies resulting in the diversion of traffic on multiple track lines for maintenance purposes. I am asking

Mr. E. T. Howson, Chairman of the Sub-Committee handling this subject, to present the report.

Mr. E. T. Howson (Railway Age):—The exacting demands for greater production and lower costs in railway maintenance, together with the wider use of power machines and tools by maintenance of way forces, are necessitating drastic changes in many of the former methods of doing work. To determine the extent to which the practice is followed of diverting traffic on multiple track lines to facilitate maintenance operations by giving uninterrupted use of the tracks during the progress of the work, a questionnaire was sent to 32 Chief Engineers and Engineers of Maintenance of Way of large roads to develop information concerning their practices. Replies were received from 31 of those roads having a mileage in excess of 197,000, a mileage sufficiently large to give a thoroughly representative survey of the practice of the country as a whole.

The investigation made by the Sub-Committee and the reports of maintenance officers from widely separated sections of the country indicate that marked savings can be effected by diverting traffic on multiple track lines to give the maintenance forces unrestricted use of the track. Some of those economies are cited in some detail on page 201 of the report.

The provisions necessary for this diversion are simple and so flexible that they can be adapted for practically every condition of grade, alinement, character of traffic and method of operation. Experience has shown that the interference with train movement, except in special cases, is little, if any, greater than when the work is carried out under traffic.

In general, operating officers are somewhat skeptical in their attitude until they have given the plan a trial, after which they are usually willing to cooperate with the Maintenance Department to the fullest extent. The time required to complete a given project is shorter, thus reducing the period of interference with train movements, while larger or consolidated gangs can be employed, with the result that slow orders are eliminated or decreased and the obstructions to traffic are concentrated at a single point.

It is very evident from a survey of the replies received from the various roads and from observations of the Committee in the field, that with the increasing use of power equipment, this problem is becoming of more direct concern to the roads, and that more and more the Maintenance Departments are going to be confronted with the necessity, if they are going to keep their costs at a low figure, of working out an arrangement with the Transportation Department whereby on multiple track lines they can get the unrestricted use of a track.

As a result of its study, the Committee offers the following conclusions, found on page 202, which conclusions it recommends be adopted for printing in the Manual. The conclusions are as follows:

"1. Under all but the most intensive traffic the practice of diverting traffic on multiple track lines to facilitate the work of the maintenance forces is feasible and when employed results in definite savings in the cost of doing the work, as well as in net savings to the railway.

"2. In addition to the economies effected, there are added benefits in larger production, better work and greater safety to the workmen.

"3. The provisions necessary for diverting the traffic are comparatively simple and can be varied to meet physical conditions or conform to operating methods.

"4. There is little, if any, added interference with train movements while the work is actually under way and operating conditions as a whole are improved, as compared with doing the work under traffic by reason of the reduction in the time required for its completion."

I move that these conclusions be adopted for publication in the Manual.

The President:—You have heard the motion, gentlemen. Is there any discussion? This is a very important subject, a very live one at the present time and one that is fraught with great possibilities for reducing maintenance costs without seriously affecting train operation.

If there is no discussion, those in favor will please say "aye"; contrary, "no." The motion is carried.

Mr. E. T. Howson:—The remainder of the report is submitted as information.

The President:—It will be so received.

Chairman F. M. Thomson:—Subject 6, Appendix C, pages 203 and 204. Mr. Lem Adams, Chairman of the Sub-Committee, is not present today, and I will present this report for him.

This subject, in some form, has been assigned to this Committee for many years.

The first report was completed in 1925, under the caption "Methods of Programming Maintenance-of-Way Work, Looking to the Most Economical Application of Labor.

Certain conclusions found on page 203 were derived but nothing was placed in the Manual.

Again, in 1926, we had assigned "The Extent to which it is Practicable to Stabilize Employment in the Maintenance-of-Way Department, in the Interest of Efficiency, and the Necessary Measures."

The study of the Sub-Committee extended over two years, and certain conclusions, also on page 203, were evolved, but nothing was placed in the Manual.

A résumé of the Committee, in the 1928 Proceedings, summed up this subject as follows:

"Your Committee in its four-year study of this subject, feels that it has covered the ground very thoroughly, and the more we have studied this matter of stabilizing employment, the more we are able to realize the economies, direct and indirect, that are to be obtained by having a trained force to perform our maintenance-of-way work, the same as we have for the maintenance of equipment.

"We do not find that the average railway officer appreciates the fact that maintenance-of-way work requires trained men. Therefore, it should be to the interest of all concerned in maintenance-of-way work to sell this idea, with the end in view of ultimately obtaining a year-around experienced maintenance-of-way force."

We now have before us the matter of the practical application of stabilization. It is difficult to see how we are to retain a fairly stable force when we do not follow the "Equalization of Expenses" plan, and are faced with current reductions in our expenses to meet the fluctuations in earnings. The year we have just passed through has been a very trying one from this standpoint, so we readily appreciate the difficulty experienced in keeping a normal force.

Your Committee finds no justification for keeping the same number of men on a track section the entire year in territory where climatic conditions

vary widely, but feels that a minimum number of men should be established for each section, based upon equated mile values, and this limit adhered to. This will provide continuous employment for a considerable proportion of the force, and train recruits for the permanent jobs.

As to bridge and building forces—the most practicable method seems to be that of a basic force assigned to a definite territory, this force to look after all general maintenance of bridges and buildings. Then when extraordinary work is needed or new buildings are to be constructed a floating force will be added to take care of it, and the foremen recruited from the permanent organization. Plumbing and water service gangs should also be handled upon a similar basis.

The regular forces should work under a definite plan for making repairs; that is, certain items should be gone over at stipulated times. This will apply particularly to painting and cleaning of structures, where a definite time limit should exist between paintings. Differing conditions will require constant vigilance on the part of supervising officers to know that forces are properly apportioned, as such items as heavy rail, with new ballast, greatly reduce section work, tending to stabilize forces.

The conclusions arrived at are:

"(1) The stabilization of forces is essential to maximum economies.

"(2) The practical method of stabilizing maintenance-of-way forces is by the establishment of a basic force that can be economically employed during slack period, and by adding to this a temporary force as required, with provision for a definite date of termination for all such positions. This will provide a fairly uniform permanent force, and train recruits to fill jobs as vacated."

The Committee recommends this report be accepted as information, and the conclusions adopted for printing in the Manual. I move that conclusions (1) and (2) of this report be accepted and printed in the Manual.

The President:—It has been moved and seconded that the conclusions on the latter part of page 204 be adopted for printing in the Manual. Is there any discussion?

Mr. J. L. Pickles (Canadian National):—The Canadian National Lines have adopted a method of issuing credentials to so-called furloughed employees, and these men are given employment where possible when there is a chance to renew them. We also ask any contractors taking contracts from the company to employ these furloughed employees, and in that way we are enabled to keep some of our valuable men whom we have spent money to educate, and keep them from drifting away to other places.

The President:—Is there any further discussion?

(The motion was put to a vote and carried.)

The President:—Before dismissing this report, I would take occasion to again mention a matter of interest which has already been brought to your attention, and that is that Mr. F. M. Thomson, Chairman of this Committee, has been honored by appointment as a Reporter to the International Railway Congress to be held in Cairo, Egypt, in 1933. He will report on "The use of mechanical appliances in the permanent way maintenance and in track relaying." That is an honor of distinction for Mr. Thomson and for the Committee which he heads.

The Committee is relieved with the thanks of the Association (Applause).

DISCUSSION ON WATER SERVICE AND SANITATION

(For Report, see pp. 399–438.)

Mr. R. C. Bardwell (Chesapeake & Ohio):—Report of Committee XIII, Water Service and Sanitation, is presented on pages 399 to 438, inclusive, in Bulletin 333.

Consideration given during the year to possible revision of the Manual was largely confined to the study of additions to water service definitions, and it was believed that the report on this subject should be deferred until the following year.

The progress report on Subject 2, pitting and corrosion, will be presented by the Sub-Committee Chairman, Mr. J. H. Davidson.

Mr. J. H. Davidson (Missouri–Kansas–Texas Lines):—This report appears on page 401 of Bulletin 333.

In our previous reports we have gone thoroughly into the theoretical phase of this subject and have also developed and discussed various available methods for inhibiting pitting and corrosion in locomotive boilers.

During the past year there have been no important developments in these two phases of the subject, and we have now reached a point in our investigation where any further definite recommendations will have to wait for conclusions of service tests that are being made. A great many service tests are being made at this time, and we are watching them very closely. The results of these service tests will no doubt be available, and be included in our next year's report.

Chairman R. C. Bardwell:—I move this report be received as information.

The President:—If there is no objection, it will be so received.

Chairman R. C. Bardwell:—The progress report on Subject 3, value of water treatment, will be presented by Sub-Committee Chairman, Dr. C. H. Koyl.

Dr. C. H. Koyl (Chicago, Milwaukee, St. Paul & Pacific):—Appendix B, page 402, is an attempt to decide under what circumstances it is possible or desirable to use anti-scale compounds of any kind, placing them either in the wayside water tank or in the engine tender.

The answer can be given only in the most general terms because of the number of variables and because of the constant improvements that are being made in the chemicals themselves and in their application.

Twenty years ago there was an engine house for engine and boiler repair about every hundred miles of railroad track, and in the bad water country it was the highest ambition of an engine crew, either freight or passenger, to make that hundred miles before boiler leaking became so bad that the engine died for lack of steam. In winter, in the worst of the bad water country, it sometimes required four engines in succession to haul the train the hundred miles.

Then came the establishment of complete water treating plants for all the worst waters, and the resultant era of locomotive runs of 900 miles or so for passenger engines and 400 miles or so for freight engines.

Your Committee is firmly of the opinion that for these very bad waters the only proper treatment is the complete treatment in wayside plants which leaves the water soft and free from precipitate.

But these treating plants are somewhat expensive in construction and there are many waters of 20 grains-per-gallon hardness and less which need some treatment but can be handled by adding the proper chemicals to the water in the wayside tanks or in the engine tenders.

Boilers using such "interior" treatment of necessity deposit the sludge in the boiler and therefore tend to foam.

The tendency to foam depends on the fineness of the sludge, the amount of sodium salts dissolved in the water, and the rate at which the boiler is worked. The cleanness of the boilers appears to depend on maintaining in the water in the boiler at all times a sodium carbonate alkalinity of at least 3 grains-per-gallon.

The permissible amount of sodium sulphate and chloride varies with the rate at which the boiler is worked but we are inclined to set 15 grains-per-gallon, as the water goes to the boiler, as the upper limit for successful operation with interior treatment of hard-worked boilers not using anti-foam compound.

For any questionable case we wish to emphasize our opinion that the difference in cost between partial treatment and complete treatment is a bagatelle beside the extra cost of running a locomotive with water which is not practically perfect.

Chairman R. C. Bardwell:—We should like to have this accepted as information.

The President:—Is there any discussion on this subject? If not, the report will be received as information.

Chairman R. C. Bardwell:—The final report, Subject 4, simplification and standardization of equipment and materials used in railway water service, will be presented by the Sub-Committee Chairman, Mr. J. P. Hanley.

Mr. J. P. Hanley (Illinois Central):—The report on the standardization of water service materials and equipment appears on pages 406 to 409 of Bulletin 333.

The first part of the report outlines briefly what has already been accomplished on this subject by the Water Service Committee of the A.R.E.A. and other agencies. For your ready reference, previous reports which contain useful information on subjects related to water service standardization are listed on pages 406 and 407. The Sub-Committee obtained information to the extent of existing standardization as applied to the principal items of water service materials and equipment by sending a questionnaire to the railways represented on the Water Service Committee. Twenty-six replies were received and the information obtained is shown in condensed form on pages 407 and 408. The items for which information was requested include pipe, pumps, water columns, tanks, treating plants, and other items widely used in water service work. The conclusions appear on page 409 and indicate that while considerable standardization has already been done, that more could be accomplished to good advantage along this line. We believe that additional standardization will simplify maintenance and decrease the amount of repair parts usually carried in stock.

The report is offered as information.

The President:—Is there any discussion upon this part of the report? If not, it will be so received.

Chairman R. C. Bardwell:—The final report is on Subject 5, automatic and remote control of pumping equipment, and will be presented by the Sub-Committee Chairman, Mr. J. A. Russell.

Mr. J. A. Russell (Pennsylvania):—The report will be found on page 410 of Bulletin 333. In this report we have endeavored to focus attention on the general application of automatic and remote control to water stations covering a wide range in daily capacity. We have attempted to bring out the fact that special equipment is not necessary or desirable and that therefore ample opportunity is afforded the railroads to decide on their own individual requirements. Modern practice is reviewed in connection with each feature of design and operation, and no conclusions have been deemed warranted.

The President:—This part of the report is submitted as information. Is there any discussion? If not, it will be so received.

Chairman R. C. Bardwell:—Your Committee has assembled considerable information, but desire to report progress on Subject 6, deep well pumping equipment, and 7, trackpans, and suggests that these subjects be reassigned for further study and report during the coming year.

The final report on Subject 8, electrolysis, will be presented by the Sub-Committee Chairman, Mr. J. J. Laudig.

Mr. J. J. Laudig (Delaware, Lackawanna & Western):—Report of Sub-Committee 8, on the protection of water supply pipe line system from electrolysis, appears on pages 415 to 419, inclusive, of Bulletin 333. This report, being in collaboration with Committee XVIII—Electricity, gives general information on identifying electrolytic corrosion, and gives procedure for overcoming the difficulties found. It is understood that remedial measures are not amplified to the extent that they can be considered directions to be followed on all occasions. We feel the information which the report gives will aid merely in the identification and assist Water Service Engineers and Electrical Engineers to overcome the difficulties which may be found; also giving information as to where more information of a more elaborate nature can be located.

The President:—Is there any discussion on this part of the report which is submitted as information? If not, it will be so received.

Chairman R. C. Bardwell:—The Sub-Committee in charge of Subject 9, coagulants, have not yet completed their study, and recommend that the subject be reassigned and study be continued.

The final report on Subject 10, chemical control and general supervision of water softening plants, will be presented by the Sub-Committee Chairman, Mr. R. M. Stimmel.

Mr. R. M. Stimmel (Chesapeake and Ohio):—The report of Sub-Committee 10, on chemical control and general supervision of water treating plants, appears on page 419 of Bulletin 333. A questionnaire was sent out and answers received from 24 roads, which have more or less extensive water treatment programs. The questions were principally concerned with the methods used in making water analyses, keeping records and reports, and with the organization of the department supervising water treatment.

The chemical tests and procedures involved in water treatment have been well worked out and control can be obtained through the application of this available information. The organization of the departments supervising treat-

ing plants necessarily varies to meet local conditions and individual needs. The success of a water treating program is largely a function of the adequacy and efficiency of this supervision and organization.

With the increasing size of power and the increased investment in these facilities the importance of water treatment is accentuated. To maintain accurate control and obtain the best results a competent and efficient organization is necessary, which will secure the co-operation of the other departments as well.

The President:—That is submitted as information. Is there any discussion? If not, it will be so received.

Chairman R. C. Bardwell:—Considerable study has been given to the question of protection of boilers and boiler materials from corrosion and deterioration while in storage, and the final report on this subject will be presented by the Sub-Committee Chairman, Mr. D. A. Steel.

Mr. D. A. Steel (Railway Age):—The theme of this report is essentially rust prevention in its several ramifications. Water Engineers do not handle or use the materials in question, but their work in water conditioning is partly measured by the service life of these materials.

This makes it appropriate to investigate factors other than the water supply which affect service life. Since the materials are handled and used by the supply and shop forces, it seemed best to attack the handling problem at its source by preparing the report more particularly for the attention of those forces than for the members of this Association.

The report, therefore, dispenses with severely technical data or formulae alluring to the Engineer and endeavors to outline the detailed practice which should be followed in each stage of handling boiler materials, from purchase to final disposition, in order to forestall the baneful effects of improper handling and use from the standpoint of corrosion in the boiler. By collaboration with the Stores and Shop Departments actual conditions in the field and the practical problems which confront the handling forces were considered in developing the report.

It may interest the Association to know that the Mechanical Division of the A.R.A. requested 200 copies of the report for the attention of shop forces and that reproductions have been made and distributed by the Purchases and Stores Division, A.R.A.; also, that the report will be published as an appendix to one of the reports of the Purchases and Stores Division.

If is felt that this treatment of the subject is consistent with the aims of the Association.

The President:—This part of the report is also submitted for information. Is there any discussion? It will be so received.

Chairman R. C. Bardwell:—The progress report on Subject 12, regulations pertaining to drinking water supply, will be submitted by the Sub-Committee Chairman, Mr. A. B. Pierce.

Mr. A. B. Pierce (Southern Railway System):—The report of Sub-Committee 12 may be found in Bulletin 333, page 429, under Appendix H.

Sub-Committee 12 has had to do with the progress being made by the Federal and State Authorities on regulations pertaining to drinking water supply and, generally, sanitation.

We have been advised by the United States Public Health Service that with the completion of the report of the Joint Committee of the A.R.A. on

Railway Sanitation there will be changes and additions to the existing regulations, which may result in necessary expenditures for improvements on many railroads.

The Joint Committee is composed of members of the Medical and Surgical Section, the Mechanical Division of the A.R.A., members of the A.R.E.A., and representatives of the United States and Canadian Health Services.

Many subjects are under discussion and investigation at this time by the Joint Committee. The report as a whole has not been completed as to form, although several subjects have been passed on by the American Railway Engineering Association. It is to be understood that regardless of whether the Joint Committee makes its final report or not, new Federal regulations are to be made, and it is hoped that they will be in line with the recommendations of the Joint Committee, which are being made to concur as closely as possible to satisfy present practice. It is given as information.

The President:—This is submitted as information, gentlemen. Is there any discussion? If not, it will be so received.

Chairman R. C. Bardwell:—The Sub-Committee has not as yet completed its study on Subject 13, sewage disposal facilities where sanitary facilities are not available.

It is recommended that this subject be reassigned for further study and report.

The final report on Subject 14, methods of laying cast iron pipe and specifications, will be presented by Mr. H. F. King, in the absence of the Sub-Committee Chairman, Mr. F. D. Yeaton.

Mr. H. F. King (Erie):—The report of Sub-Committee 14, methods of laying cast iron pipe and specifications, will be found on page 430 of Bulletin 333.

This report has been revised in accordance with the ideas of the Association as expressed on the floor of the convention last year.

It is recommended that the final report, pages 430 to 435, on methods of laying cast iron pipe be accepted as information and that portion of the report on pages 435 to 438 giving specifications for laying cast iron pipe be accepted for inclusion in the Manual.

The President:—It has been moved and seconded that these specifications for laying cast iron pipe be approved for printing in the Manual. Is there any discussion?

Mr. Louis Yager (Northern Pacific):—I should like to inquire of the Committee what the significance of the last sentence in the first paragraph under Measurement, on page 436 is, in which they speak of making the measurement. The last sentence says: "Backfilling of the trench shall be included in the excavation measurements." In the first part of the paragraph they say "Measurements shall be made in excavation only." What is the significance of the sentence concerning the backfilling?

Mr. H. F. King:—That is, the backfilling is part of the cost of the trenching, to be included.

Mr. Louis Yager:—I would think that would be correct, but why include it under measurement and say that shall be included in the excavation measurements? If the measurement is in the excavation, that is all there is to it. Why measure the backfilling?

Mr. H. F. King:—That last sentence could be omitted.

The President:—The Committee agrees that that sentence can well be omitted from the specification. Is there any further discussion? If not, those in favor of the adoption of these specifications will please say "aye"; contrary, "no." The motion is carried.

This is a hard and systematically working committee. I do not know what the railroads would have done in the drought areas but for the excellence in water service methods and the organizations which the railroads have built up, and for which this Committee and its membership are largely responsible. But for this the railroads would have been flat on their backs in many places, in many sections of the country. As it was, they passed through unscathed.

The Committee has done excellent work. Their work has been of inestimable value to the transportation system of the country. The Committee is to be highly congratulated. It is relieved with the thanks of the Association (Applause).

DISCUSSION ON RAIL

(For Report, see pp. 345–398.)

Mr. Earl Stimson (Baltimore & Ohio):—Before the Committee presents its report, it is perchance fitting that the Committee announce that it has sustained a very severe loss during the past year through the death of Richard Montfort, Consulting Engineer of the Louisville & Nashville Railroad. Mr. Montfort was a Charter Member of the Association and had been a member of the Rail Committee since its formation. He was a gentleman of the highest type and an Engineer of eminent ability. He was a regular attendant at the meetings of the Association and of the Committee, and his genial presence and helpful suggestions will be missed by all.

The first subject to be presented is Revision of Manual. The subject will be handled by Mr. Blaess, the Chairman of the Sub-Committee handling the subject.

Mr. A. F. Blaess (Illinois Central:—The report of Sub-Committee 1, revision of Manual, will be found on pages 346 to 354, inclusive, of Bulletin 333.

Form 402-A—Report of Rail Failure in Main Track. The changes proposed in Forms 402-C and 402-E drew the attention of the Committee to this form, and it was found that there were three different styles of this form in general use by railroad members of the Association. Committee recommends that the question of drawing up one form that might be found acceptable to all railroads be assigned to it for investigation and report during the ensuing year.

Form 402-C—Rail Failures for Year Ending. Present form is of a very unwieldy size for filing and certain changes are desirable in the data called for on form, among these being a change in the termination of the report year from October 31st to December 31st, and the addition of a column to show failures found by the detector car. It also seems desirable to have the instructions for filling in the form printed separately.

Copies of proposed revised form 402-C and of the proposed new instruction form 402-C (a) are shown, and Committee recommends their adoption.

Form 402-E—Statement of Transverse Fissure Rail Failures. Some

ambiguity arises in connection with mill designation under this form, also a column should be added for failures found by the detector car. It also seems desirable to have the report year end on December 31st instead of January 31st, as at present, to agree with the report year recommended for Form 402-C; also to have the instructions for filling in this form printed separately.

Copies of proposed revised form 402-E and of the proposed new instruction form 402-E (a) are given, and Committee recommends their adoption.

Form 402-F—Manufacturing Record of Transverse Fissure Rail Heats. This form no longer serves any useful purpose and has been omitted from the Manual, but through oversight the question was not submitted to the convention for formal approval. The Committee recommends discontinuance of this form.

Revision of Definition of No. 2 Rails—The Committee recommends that the present definition be retained.

Preparation of Specifications for Intermediate Manganese Steel Rail: The Committee recommends that the suggested specifications shown in the Committee report of March, 1930, be retained and no modification be made therein until further experience with this material indicates definite changes or additions needed.

Design of Track Bolts: Attention is called to Supplement to the Manual of 1929, Bulletin No. 327, July, 1930, page 17, which corrects certain typographical errors appearing in the design for track bolts adopted last year and appearing in Bulletin 324, February, 1930, and in Volume 31, Proceedings for 1930, page 1463. The Committee recommends that Note 3 to Table 3—"Square and Hexagonal Nuts for Track Bolts," be changed from "The recessed type of nut shall have a recess of 1/8 inch" to read "The recessed type of nut shall have a recess of 1/8 inch minimum and 3/16 inch maximum"; to agree with like revision since made in the American Standards Association designs.

Branding of Tee Rails, with a view toward standardization. Branding—Exhibit E shows typical branding with data to be given and order of arrangement. Stamping—Exhibit E shows typical stamping recommended, and Exhibit F shows complete list and design of letters and numerals.

In connection with the Exhibit E showing the typical stamping, it is the desire of the Committee to eliminate under the heading "Typical Stamping" on page 353, the last two words on the top line. That would make it read "Showing recommended data and design of letters and numerals to be used," eliminating those two words.

It is the recommendation of the Committee that revisions of Form 402-C and 402-E as shown in Appendix A, Exhibits A and C, be approved and substituted for present Form 402-C and 402-E in the Manual. I so move.

The President:—You have heard the motion, gentlemen. Is there any discussion? This is under the subject of revision of matter now in the Manual. If not, those in favor will please say "aye"; contrary, "no." It is carried.

Mr. A. F. Blaess:—It is recommended that new Form 402-C (a) and 402-E (a) shown in Appendix A, Exhibits B and D, be approved for inclusion in the Manual. I so move.

Mr. Charles S. Churchill (Consulting Engineer):—I have been doing my discussion of the Rail Committee Reports for two or three years by writing

letters to the Chairman of that Committee, on the point I advanced. I dislike these forms because they do not make a provision for reporting in "million tons" the tons carried by the rails of main tracks.

Apparently the Committee has adopted my line of thought on page 357 in two places to the effect it is the more accurate way because it gives the real work the rail does as shown by diagram No. 4 on page 361, as against diagram No. 3 on same page above. The latter only attempts to give the report of failures per hundred miles of track, which is not of any great value as it is not accurate. Referring to known cases on the Norfolk & Western Railway; business nearly doubles, therefore the work of rails often doubles within a distance of 100 miles, as the Committee has finally pointed out. The plan that gives the work of the rail as near as the Engineering Department of a railroad can determine, is the best one to go on record as per diagram No. 4, page 361. Some examples of changes in density of traffic within short distances on the Norfolk & Western Railway: (The density of traffic is obtained from the reported ton miles per year being changed to the density on each track mile during same year.)· On the Eastern end of the Norfolk & Western Railway between Norfolk and Roanoke, the density per mile per year is 21 million tons; while between Lynchburg and Durham on the same Division, it is only 2½ million tons per year. Between Hagerstown and Roanoke it is 9½ million tons. Between Roanoke and Bluefield, it is 27 million tons. While on a short district between Radford and Bristol, it is only 5½ million tons per mile.

Bluefield to Williamson has a density of 32 million tons per mile; while on the district between Bluefield and Norton, it is only 6 million tons per mile. Between Williamson and Portsmouth, and Portsmouth to Columbus, the average density per mile is 43 million tons. Whereas, between Portsmouth and Cincinnati, it is only 7½ million tons.

That is enough to indicate that a report giving only the number of rail failures in a year per 100 miles of main track, is not the information that is most needed now. What is needed is the "real work of the rail" each year and during its life and what is the total tonnage carried by it.

When one starts with the ton miles for the entire railroad, which fact every road obtains each year for itself, it is possible to obtain the density in million tons carried on main tracks of different sections of a division or district of that railroad.

I am asking you not to go too fast now with these new forms until you provide columns in which a railroad can report the failures of rail in terms of total million tons carried by the failed rails. Ask the Committee to get all railroads to report this.

Mr. A. F. Blaess:—We are glad to have your suggestions, Mr. Churchill. We have given careful consideration to arriving at some method for making use of the density of traffic, but we have not found a real practical way. It is not so easy at all times to develop the density of traffic. Some railroads may have that information but others have not.

Mr. Chas. S. Churchill:—The Chief Engineer of the Norfolk & Western Railway will furnish the Rail Committee the information if called for, as its records extend back to about 1904. Its preparation requires some work; but it pays to secure the information. Rail mills need it just as much as the railroads. In these days, all users of rails desire a knowledge of the work done by them.

The President:—Is there any further discussion? If not, I will put the question. Those in favor of the motion will please say "aye"; contrary, "no." It is carried.

Mr. A. F. Blaess:—It is moved that the present form 402-F be discontinued.

The President:—You have heard the motion, gentlemen. Is there any discussion? If not, those in favor will please say "aye"; contrary, "no." It is carried.

Mr. A. F. Blaess:—I move that the recommendations in Appendix A and Exhibits E and F covering branding and stamping practice, with such changes as I have outlined under the heading of stamping, be approved for inclusion in the Manual.

The President:—Is there any discussion? If not, those in favor will please say "aye"; contrary, "no." It is carried.

Chairman Earl Stimson:—In connection with Subject 2, mill practice, the Committee wishes to announce that the co-operative rail investigation and research work is under way. The arrangement as outlined in the Committee's report last year has been effected and the money is available. Agreement has been entered into between the Engineering Experiment Station of the University of Illinois, the Rail Manufacturers Committee and your Rail Committee to carry on this work.

The Association will have to be a little patient. It takes some time to get a work of this kind under way, and some time before definite results can be obtained or results upon which even preliminary conclusions may be based. By next March we hope to be able to present a satisfactory progress report.

The third subject, operating results of the A.R.A. Rail Fissure Detector Car, is quite fully covered in the Appendix C. Rail failure statistics for 1929, Appendix D; transverse fissure statistics, Appendix E. These are matters of information, largely statistical, and no further comment will be made.

We now come to Subject 4, cause and prevention of rail batter, which will be handled by Mr. F. M. Graham, the Chairman of the Sub-Committee.

Mr. F. M. Graham (Pennsylvania):—This is a progress report of the activities of the Sub-Committee during the past year and contains nothing more than information collected, with the thought that we should arrive at something of definite value in perhaps another year or so. The only thing to add to what is stated here might be that we are finding some evidence of increase of batter due to joint opening. The percentage of increase, we are unable to say.

We will endeavor to make further study of the effect of hardness of different rails upon the progress of batter. We perhaps will be able to make more accurate measurements of the hardness of the rail.

I do not know that there is anything further to add to what is contained in the report, and I offer this as a progress report.

The President:—Is there any discussion of the report? If not, it will be so received.

Chairman Earl Stimson:—Subject 7, tests of alloy and heat treated carbon steel rails, will be presented by Mr. Chapman, in the absence of Mr. Bronson, Chairman of the Sub-Committee.

Mr. E. E. Chapman (Atchison, Topeka & Santa Fe):—Questionnaires were sent to the various railroads to obtain the information, and the replies and summaries are shown in Exhibits A and B.

On intermediate manganese rails, a résumé of the questionnaires is given below, showing a total of about 650,000 tons of this type of rail now in service. This shows, in general, that the interior transverse fissures are far from numerous, and reports indicate they are much lower than experienced with standard open-hearth rails. The data also tends to show that on wear, battering and chipping, there is considerable reduction as a general proposition compared with standard open-hearth rails.

Comprehensive studies that have been made through a number of sources indicate the desirability of lowering the specified carbon range two or three points, and the manganese range five to ten points. By this means, along with complete hotbed protection, horizontal and split heads should be less numerous to a considerable extent. Several roads have changed their specified carbon and manganese ranges in line with the above.

To date, the greater part of the failures in the intermediate manganese rail has been due to the horizontal and vertical split heads. A check of the questionnaires with respect to the intermediate manganese rail gives general results which the various roads have obtained to substantiate the report which is given under Exhibit A.

Under heat treated rails, replies to the questionnaire indicate that the railroads have been marking time during the past year so far as heat treated rails are concerned. The only new tonnages reported are 500 tons for the Delaware and Hudson, and 150 tons for the Interborough Rapid Transit Company, which were purchased from the Steelton plant, Bethlehem Steel Company.

The reports show that no failures of any type have developed which is all the more remarkable when consideration is given to the fact that these heat treated rails are in about the most severe service on the various railroads.

Batter and chipping, as well as crosswise flow, particularly on the low side of curves, is much less for treated compared to untreated rails.

I believe since this report has come out the Pennsylvania have placed the heaviest order for heat treated rails that has been given in the country to date.

Chairman Earl Stimson:—In presenting the recommendations of Revision of Manual for vote, we overlooked the recommendation on design of track bolts, which is changing the wording of a clause in regard to the recess type of nut so as to conform to the revision made by the American Standards Association.

I therefore move that the recommended change in this clause be approved.

The President:—This is found at about the middle of page 347 of the Bulletin. Is there any discussion? If not, those in favor of the motion will please say, "aye"; contrary, "no." It is carried.

Chairman Earl Stimson:—This concludes our report.

The President:—When this Committee recommended in 1924 and the Association adopted a standard section for 150-lb. rail, it was perhaps thought by some of us that this was somewhat in advance of the times. It is of interest to know that the Pennsylvania Railroad has recently placed a larger order, or is placing it now, for a 152-lb. rail. I wonder if Mr. Cushing could tell us anything of interest in this connection. Apparently he is not in the room.

This is, as we all know, one of the subjects of great importance to the railroads. There is now proceeding what we hope is a marked development in the manufacture of steel rails.

Mr. Graham, could you tell us anything about the large rail?

Mr. F. M. Graham:—Of course I know nothing of the performance of the new Pennsylvania 152-lb. rail. This rail is to be eight inches high, with a base-height ratio of about 0.84. It has about the usual proportions of head, and a 1 to 40 slope on the side of the head. I cannot recall all the dimensions that would be of interest to you. Of course, the weight gives you some conception of that in view of the general dimensions. It is intended, of course, to be a very stiff rail and to minimize local variations in tie-supporting conditions. It also should, we hope, give us a good, strong joint arrangement by providing a very large depth of joint bar.

These rails are to be rolled in 39-ft. lengths at this time and are to be of practically the present chemistry which I think you are all using.

I think that is all that I can recall just now that might be of interest.

The President:—Thank you, Mr. Graham.

The Committee is relieved with the thanks of the Association (Applause).

DISCUSSION ON TRACK

(For Report, see pp. 150–164.)

(Past-President Louis Yager in the chair.)

Mr. J. V. Neubert (New York Central):—This report is contained in Bulletin 330, beginning on page 152. The first item, under Appendix A, revision of specifications for steel tie plates, will be presented by the Sub-Committee Chairman, Mr. E. D. Swift.

Mr. E. D. Swift (Belt Railway):—This report appears as Appendix A, page 152, Bulletin 330. Subject 1-A concerns specifications for steel tie plates and the Committee is making three recommendations: First, that Section 11 (b), as it now appears in the Manual, be withdrawn and a revised version to read as follows be substituted:

"Section 11 (b). For plates with shoulders parallel to the direction of rolling, a variation of 1-32 in. in thickness, 1-8 in. in rolled width and 3-16 in. in sheared length will be permitted when no camber is required. When rolled in camber is specified, a variation of 1-4 in. in sheared length will be permitted."

Approval of this revision is recommended.

The second recommendation is that a section to be known as Section 3 (d) be added to this specification. This new section is to read as follows:

"Section 3 (d). When copper is specified the percentage contained in the steel shall be not less than 0.20 of 1 per cent."

Approval of this section is recommended.

Past-President Louis Yager:—You have heard the motions. Is there any discussion? Those in favor signify by saying, "aye." Contrary, "no." It is carried.

Mr. E. D. Swift:—The third recommendation as I shall read it is changed somewhat from what appears in the Bulletin report. It is to read as follows:

"Section 11 (e). Regardless of variations otherwise permissible, the weights to be paid for shall not exceed by more than 3 per cent the weights calculated from the specified dimensions."

I move approval of this recommendation.

Past-President Louis Yager:—You have heard the motion for approval of the additional recommendation modified as has been read to you. Is there any discussion? If not, those in favor signify by saying, "aye." Contrary, "no." It is approved.

Mr. E. D. Swift:—The concluding part of the report concerns revision of specifications for soft steel track spikes. This is Subject (1-B), and the Sub-Committee reports progress at this time.

Past-President Louis Yager:—If there are no questions the report will be received as progress.

Chairman J. V. Neubert:—That last subject is to be continued this year and reassigned.

At the top of page 152 appears Appendix B, superelevation of the outer rail on curves in connection with the degree of curvature, gradient, the maximum speed of trains, traffic, number of tracks, etc. This will be presented by Mr. C. W. Breed, Chairman of the Sub-Committee.

Mr. C. W. Breed (Chicago, Burlington & Quincy):—After careful consideration of this subject by the Sub-Committee at various meetings, we wish to recommend that this subject be withdrawn. We feel that the Manual and the Proceedings of the Association contain very complete information on curve superelevation. If we attempt to tabulize each case we will probably be misunderstood and complications will result.

In support of this recommendation the following facts are submitted: There are 112 pages of data about the superelevation of the outer rail on curves in the publications of the Association. The information contained therein are the best views of the engineering members over a period of thirty years. There are formulas and full information as to their development for equilibrium superelevations, for superelevations in which resultant of forces passes through edge of middle third, etc.; there are tables of superelevations for most of the formulas shown.

There are tables and graphs showing speeds of trains through turnouts, and general information on all cases of superelevation. In addition to this, the specific experience and individual curve elevation tables and practices of some forty Class I railroads appear in the 1929 Proceedings.

When we consider the infinite number of superelevations required on all the individual curves on all the railroads, it will be appreciated that it is not practical to attempt to tabulate or classify them. An Engineer desiring to set up the superelevations over a particular railroad will find from the Proceedings and Manual that he must first determine the speed of traffic over each curve. If both passenger and freight traffic are in operation over the curve, he knows that there will have to be a compromise in the amount of superelevation. He cannot give the passenger traffic the full benefit of equilibrium superelevation because he does not wish to subject the inner rail of the curve to the excessive wear from slower moving freight traffic.

If the freight traffic over the particular curve is comparatively fast, due to favorable gradient or other causes, then the Engineer should follow the practice of many Engineers as shown in 1929 Proceedings, and choose the equilib-

rium elevation for a speed 5 to 10 miles less than the maximum speed of passenger traffic over that curve.

On other lines where there is a preponderance of comparatively slow freight traffic it may become expedient to superelevate the outer rail of curves for the speed of this traffic, restricting the speed of passenger trains, if necessary, to preserve safety and comfort over those curves.

If there is passenger traffic only or freight traffic only over a particular curve, the information in the Proceedings indicates to the Engineer that he should superelevate that particular curve the amount shown as equilibrium superelevation in the Manual for the maximum speed determined for the passenger train over its particular curve or the freight traffic over its particular curve.

If these basic rules are followed in determining superelevation and first consideration is given to safe travel, there is not required any information other than now appears in the publications of the Association.

I move that this subject be withdrawn.

Past-President Louis Yager:—This subject, which is virtually an assignment to study any possible revisions of material in the Manual, has been in the hands of this Committee for at least two years. They now come to you and justify the work that has been done before, and they recommend that the assignment be withdrawn.

In view of the fact that this has been assigned to the Committee, and that they are now satisfied that the previous work was well done, for the benefit of the Outline of Work Committee it will be well to have some discussion on the report that has just been submitted. If you are satisfied that the work has been well done and completely covered, we should like to have that expression. Otherwise, if you feel that the Committee has overlooked something, the Committee on Outline of Work would like to know that also. Are there any questions?

Mr. C. W. Breed:—In the Proceedings of 1929 there was a reference made to page 899 of the Proceedings in the Manual. That should be corrected to page 916. I move that that change be made.

Past-President Louis Yager:—That change will be made. If there are no questions the report will be received as information.

Mr. C. W. Breed:—Under Appendix C, string lining of curves by the chord method and prepare tables suitable for the use of trackmen, the Committee is working on tables and will have a final report next year. We report progress only.

Past-President Louis Yager:—Are there any questions? If not, the report will be received as information.

Mr. C. W. Breed:—On page 164 appears Appendix K, covering Subject 11, gage of track and elevation of curves, with reference to the use of roller bearings on railway equipment. That report is submitted as progress.

Past-President Louis Yager:—The report will be received as progress.

Chairman J. V. Neubert:—On page 155 appears Appendix D, covering temperature expansion for laying rails.

A questionnaire was sent out, both in 1929 and 1930, in regard to determining whether we should adhere to the present temperature expansion as contained in the Manual of 1929, page 243, or have the same modified. That

questionnaire included not only the present table but four other schemes, known as Schemes 1, 2, 3 and 4.

The Committee felt that we should not show the expansion for the 45-ft. rail as there was little or none used, and the table of expansion can include longer rail when it is more or less generally used.

The number of questionnaires sent out was 194; the number of replies received was 68. Those favoring the present A.R.E.A. table numbered 11; those favoring Scheme No. 1 numbered 21; those favoring Scheme No. 2 numbered 2, those favoring Scheme No. 3 numbered 3, and No. 4, 12. The alternates on Schemes 1 and 4 were that they swapped between the 33-ft. and 39-ft. rails.

There were but very few who were not in favor of discontinuing the showing of the expansion for the 45-ft. rail, as little or none was used. Some claim we should work up tables including the 66-ft. rail, and possibly consideration being given to longer rails.

After very careful thought and consideration, the Committee recommends that the information shown in table in the Manual of 1929, page 243, headed: "Temperature Expansion for Laying Rails," be withdrawn, and recommends that Scheme No. 1, given below, be adopted as recommended practice.

"Temperature Expansion for Laying Rails.—(1) When laying rails their temperature should be taken by applying a thermometer to head of rail, and taken periodically during the day, as the temperature of the rail can change decidedly from the early morning hours to the later afternoon hours, in winter as well as summer time laying.

"(a) To allow for expansion, openings between the ends of rail should be as follows," which I won't read to save time.

I move that this be adopted and included in the Manual.

Past-President Louis Yager:—You have heard the motion, gentlemen. It is now open for discussion. You know that this involves the elimination of material that has been in the Manual for some time, substituting a new table which is thought to be more in line with the present ideas prevailing with respect to the necessity for expansion. Is there any discussion? If not, those in favor of the motion will signify by saying, "aye"; contrary, "no." It is carried.

Chairman J. V. Neubert:—Appendix E, shown at the top of page 157, covers plans and specifications for track tools. This work has been handled by Mr. G. M. Strachan, Chairman of the Sub-Committee. At this time we have no additional plans or specifications to those contained in Volume 31, Bulletin 321, November, 1929, beginning on page 555.

The Committee at first was going to recommend certain of these plans and specifications, but after very careful thought and consideration we felt that they should be before the Association another year and then we will cite such of them that we can consider for recommended practice the coming year.

Next is Appendix F, plans for switches, frogs, crossings, slip switches, etc. In the absence of Mr. C. R. Harding, Chairman of the Sub-Committee, this report will be submitted by Mr. Wakefield.

Mr. C. H. Wakefield (Southern Pacific):—In line with its work in other years this Sub-Committee has been engaged in modernizing and amplifying the portfolio of trackwork plans.

Although a number of the present plans are under consideration for revision or withdrawal, as outlined on pages 157 and 158 of Bulletin 330, this

year's completed work consists in the submission of two new plans as information and one revised plan for adoption as recommended practice.

These three plans are shown facing page 158 of the Bulletin. Plans Nos. 260 and 262, covering No. 8 and No. 10 frogs for medium weight rails, railbound manganese steel, bolted rigid, spring rail and solid manganese steel, are new, and are typical of a series to be prepared which will be similar to the existing series for heavy rail.

Plan No. 510, covering manganese steel one-piece guard rail on six ties, which was presented as information two years ago, has been revised by the addition of notes which relate to the marking and setting, and by making some other minor changes.

It is recommended, and I so move, that Plan No. 510, dated October, 1930, A.R.E.A. manganese steel one-piece guard rail on six ties, be adopted as recommended practice and printed in the Manual.

Past-President Louis Yager:—It has been moved and seconded that the plan submitted, No. 510, on manganese steel one-piece guard rail on six ties, which has been before you now for two years, be adopted as standard practice and included in the Manual. Is there any discussion? If not, those in favor will signify by saying, "aye"; contrary, "no." It is carried.

Mr. C. H. Wakefield:—It is recommended, and I so move, that Plans Nos. 260 and 262, dated October, 1930, A.R.E.A. No. 8 and No. 10 frogs for medium weight rails, rail bound manganese steel, bolted rigid, spring rail and solid manganese steel, be received as information and to invite criticism.

Past-President Louis Yager:—If there are no questions they will be so received.

Chairman J. V. Neubert:—At the top of page 159 is Appendix G, track construction in paved streets. This subject is handled by Mr. E. W. Caruthers, who is Chairman of the Sub-Committee.

This Committee has covered its subject very well, but it has other plans in view. At this time we have nothing to present, and just wish to report progress, and recommend that this subject be continued.

On the same page is Appendix H, corrosion of rail and fastenings in tunnels. Mr. C. J. Geyer is Chairman of the Sub-Committee.

Mr. C. J. Geyer (Chesapeake & Ohio):—The Committee's report last year indicated that corrosion was negligible in tunnels under 1000 feet in length; medium in tunnels 1000 to 2000 feet in length; heavy in steam operated tunnels over 2000 feet in length where special drainage had not been provided.

Further study of questionnaires and additional information received too late for last year's report tends to confirm the opinion that corrosion is materially reduced by good drainage and good ventilation, and further minimized by coating the rails and fastenings with a heavy oil, or some paints.

The Sub-Committee is now attempting to find the money loss account of corrosion and the approximate cost of preventive measures.

It is recommended that this report be received as information and the study continued.

Past-President Louis Yager:—Are there any questions? If not, it will be so received.

Chairman J. V. Neubert:—On page 160 is Appendix I, methods of reducing rail wear on curves, with particular reference to lubricating the rail or wheel

flanges. This report will be presented by Mr. C. M. McVay, Chairman of the Sub-Committee.

Mr. C. M. McVay (New York Central):—You will find this report on page 160. The Committee has had this subject now for three years, and in the first paragraph we mention the previous reports made, which are found in Volumes 30 and 31 of the Proceedings.

We have presented during this time a series of information as to results secured from oiling, and also some information on the cost. We find this year that most of the information we are getting seems to be a duplication so that the Committee asks that this subject be discontinued for the time being, at least until something additional develops.

The report is in error in that we asked to publish the conclusions, starting at the bottom of page 160 and continuing on page 163, in the Manual. It is not desired to publish these in the Manual at present, but we merely ask that you receive the report as information.

Past-President Louis Yager:—Are there any questions on this subject? If not, the report will be received as information, and the Committee on Outline of Work will take the recommendation into consideration.

Chairman J. V. Neubert:—On page 163 is Appendix J, cause and effect of brine drippings, and submit recommendations. This subject will be handled by Mr. W. G. Arn, Chairman of the Sub-Committee.

Mr. W. G. Arn (Illinois Central):—Since this Bulletin was published, additional information has been furnished as to the use of dry ice in refrigerator cars. An article on this subject will be found on page 363 of the Railway Age for February 14. It indicates that there is considerable promise in the use of this refrigerant as a solution of the trouble.

As to the report, at the convention last March the Committee submitted the following recommendations which are shown in Bulletin 321 of November, 1929, Volume 31, pages 596-597.

"(1) That the railroads require the maintenance of brine retaining apparatus on the meat-carrying or bunker type of cars in the best possible shape.

"(2) That the Mechanical Division continue vigorously its efforts to perfect a design for the fruit and vegetable carrying car that will permit of installation and operation of brine retainers on this type of car.

"(3) That the effort on the part of the car companies and refrigerant manufacturers to find a refrigerant which will take the place of ice and salt, and eliminate entirely the making of brine, and consequently its damage, be encouraged by the A.R.A. and the individual railroads.

"(4) That in the meantime the railroads continue the application to their structures of the protective agents mentioned and being tried on the various systems, and further to make tests of any additional agents which offer promising possibilities.

"The convention accepted the above report as information and the subject was reassigned."

It is now recommended that this report be adopted and request be made of the American Railway Association that it take action on the above recommendations 1, 2, and 3. I move the adoption of the report.

Past-President Louis Yager:—Action for approval of the recommendation of the Committee is now before you. Is there any discussion?

(The motion was put to a vote and carried.)

Chairman J. V. Neubert:—Appendix K has already been explained by Mr. Breed, Chairman of the Sub-Committee.

The next subject is Appendix L, effect of existing materials in track on the design of tie plates and punching thereof, together with the interrelation of slotting of joint bars and size of track spikes. This subject was handled by Major Macomb, Chairman of the Sub-Committee. We just wish to report progress, and recommend that this subject be continued. It is unfortunate, possibly, for you that we have not presented some definite report in the past year, but it is a very trying problem to get the maker and the user on a uniform basis with regard to some of these practices. We hope next year we can give you some.

Past-President Louis Yager:—Are there any questions that anyone has to put to the Committee before they are excused? If not, the Committee is excused with an acknowledgment of their usual high quality of work (Applause).

DISCUSSION ON ECONOMICS OF RAILWAY OPERATION

(For Report, see pp. 641–701.)

(Past-President Louis Yager in the chair.)

Mr. J. E. Teal (Chesapeake & Ohio):—The report of the Committee on Economics of Railway Operation will be found on page 641 of Bulletin 334.

The Committee desires to report progress concerning Assignments 1, 4, and 7. It desires to change action recommended concerning Assignment 2. This assignment should read, "The report of Sub-Committee, Appendix A, be received for publication in the Manual." Assignment No. 2, Appendix A, will be presented by Mr. Mannion, Chairman of the Sub-Committee.

Mr. M. F. Mannion (Bessemer & Lake Erie):—Sub-Committee 2 has been studying the problem of increased capacity for several years. During this period the effect of various changes in operations have been reported on. This year the Committee felt it advisable to assemble, condense and bring up to date the past reports of the Sub-Committee. This year's report is shown as Appendix A, pages 643 to 692, Bulletin 334.

On pages 643 to 646 you will find a discussion of the steps to be taken in making a study of railroad operation with a view of increasing capacity with existing facilities.

On pages 647 to 652 is a synoptical outline of some of the elements which affect the capacity of a railroad, and following this outline is a brief discussion of a number of the items.

The subject is covered in an elemental way but its purpose is to indicate the method of procedure, for it is evident that each case will present a problem in itself and will require modification of any general treatment.

Beginning on page 652 is discussed the study of railroad operation with a view of increasing its capacity by providing additional facilities. First, traffic capacity is discussed. Next, on pages 653 to 659, there is defined track capacity of a single track and double track line, and also the method of determining this capacity.

The effect of fleet operation on track capacity is also shown, together with typical train charts showing simple cases of perfect operation.

On page 657, the relation of actual to theoretical track capacity is discussed, and on page 658 is the formula for computing theoretical track capacity.

At the bottom of page 658 and on page 659 is discussed the effect of operation of two classes of trains and Fig. 7 to 12 on pages 660 and 661 are typical train charts showing simple cases of perfect operation of trains of two classes.

From page 659 to 666 the train hour diagram and the crew expense diagram are explained.

An example of the crew expense diagram is worked out to show what the effect would be if the basic day were changed from 100 miles or less, 8 hours or less, to 100 miles or less, 6 hours or less.

On pages 666 to 670 is described a model for studying train hour diagrams. This description, along with Fig. 17, 18, 19 and 20, helps to bring out some of the relationships which are demonstrated mathematically in Exhibit A.

On pages 670 to 674, there is a discussion of the log of freight train performance, or performance charts. These charts are a simple means of comparing current and previous month's or current and previous year's operations, and also operations before and after additional facilities have been installed.

At the bottom of page 674 is a statement showing where the Committee has applied the train performance charts and train hour diagrams to various studies, and on pages 677 to 681 is given a brief summary of the results of these studies.

Exhibit A on pages 683 to 692 is a discussion of the mathematical theory of a probability curve and the similarity between the typical train hour diagram and the probability curve.

On page 681 are the conclusions, which I will read:

"(A) (1) It has been found that train operations can be represented by a mathematical law.

"(2) The application of this law to different sets of observations make it possible to compare several months' operation of a given division on a more equal basis. Likewise, operations of different divisions which are more or less similar can be compared on more nearly the same basis.

"(3) By such comparisons the effect of extreme weather conditions, greater facilities, motive power, different commodities, and supervisory methods on the average time on the road can be more accurately determined.

"(B) (1) Increased supervision, consisting of scientific study and thoughtful effort, will increase the capacity of a railway.

"(2) Increasing capacity of locomotives results in an equal increase in capacity of the railway.

"(3) Double tracking will increase the capacity of a railway. The increase in capacity being proportional to the amount of second track. Careful study should be given to practicability of increasing capacity of single track and obtaining more intensive use of same, either by increased supervision and study of operations, signals, etc., before constructing double track.

"(4) Installation of automatic signals on a single-track railway will increase the capacity of the road, this increase varying with the length of division on which installed and with the number of passenger trains operated.

"(5) Installation of complete signal dispatching system on a single-track railroad will increase the capacity of the road. This method of increasing capacity should be considered when the volume of traffic justifies, or when other conditions necessitate.

"These studies have been undertaken to test out the theory of train hour diagrams and obtain experimental knowledge which would serve to extend the scope of the method in connection with the investigation of other factors relating to freight train operation.

"From a qualitative standpoint, comparative freight train performance charts provide a simple and accurate method for showing actual results obtained by various methods of operation or changes in facilities. In order to analyze the results or forecast the effect of proposed improvements, it is necessary to develop a mathematical theory to account for some of the relations which have been found to exist. A discussion of the mathematical theory will be found in Exhibit A."

The Committee recommends that this report be received for publication in the Manual.

Mr. W. A. Radspinner (Chesapeake & Ohio):—In speaking of locomotives, there are certain terms that are applied to various operations that are recognized by both the Operating Department and by the Mechanical Department.

On page 650 there is one paragraph devoted to running repairs. Half-way down the paragraph there is the following sentence: "Running repairs are those required to place the locomotive in condition for a successful trip over the district." I do not think that is right. Running repairs are repairs that can be applied to the locomotive in twenty-four hours, and any repairs, even though caused by a delay in material, which take over twenty-four hours, are charged to repairs to locomotives or a separate account.

At the top of the page there is this sentence: "A freight locomotive, after receiving general repairs should be good for approximately twelve months' service." General repairs are generally spoken of in terms of classified repairs, and each one of those repairs calls for a definite mileage, and mileage is the yardstick by which they repair locomotives. The time factor does not enter into it.

In this day and age of the world, locomotives are making continuous runs of 900 miles, and a great many of the freight locomotives regularly change crews at terminals and run 300 or 400 miles. These locomotives are certainly going to be in need of repairs before a locomotive that has gone only 100 miles. and redispatched with a 3 or 4-hour terminal delay after each trip.

Under the caption of "Preparation" on page 650, and in another paragraph on page 651, captioned "Ashpit, Turntable, Coal Tipple and Ready Track Operation," there are described operations that are generally known as dispatchment of locomotives, which operation is recognized as such the same as train dispatching or crew dispatching and has its own particular part in the operation of the Mechanical Department. It seems to me that if this report is to be put in the Manual these different operations should be captioned under the head and in terms by which they are generally recognized.

Mr. M. F. Mannion:—The only comment I wish to make on that is this: As was stated, the idea of the Committee was to outline a method of attacking this problem. It was to call attention to the different features of operation which should be studied and just a few comments were made, not trying to recommend that you should consider everything exactly as stated in the report. It was known that each different study would have to be considered on its own merits. If the run over a district was 100 miles, or 300 miles, naturally you would try to make such repairs to your locomotives that would get them over the district, no matter how long it was, without having to send another locomotive out to relieve them. The idea in mentioning repairs for a year was to bring out the percentage of total locomotives that should always be in good repair. It was not intended to define what should be classified as running repairs or heavy repairs.

Past-President Louis Yager:—This Committee has brought to you a résumé of the work that it has been doing practically since the Committee was organized. This is their first attempt at a sort of preliminary draft, to gather together all the fundamentals of the studies which they have made for you. I think you will recognize that it is going to be quite an undertaking to get this in concise shape for inclusion in the Manual. There is a great deal of valuable information here which justify eventually its inclusion in the Manual. The Committee solicits your assistance in discussions and suggestions for improving this skeleton outline as it is, so that eventually they will be able to present to you the finished product for final adoption.

Are there any other questions or discussions?

Prof. S. N. Williams (Cornell College):—I wish to express my pleasure and great satisfaction with the very careful study which the Committee has made of this important subject. They deserve high praise, I think, for the work which they have done.

Past-President Louis Yager:—Are there any further remarks? This report will be received as progress information. As I stated before, it is the Committee's first tentative draft of what is to follow.

The Secretary calls my attention to an apparent misunderstanding The Committee does place before you for approval a definite recommendation. I took it that they asked you to approve the idea that I have just outlined to you, and that they were agreeable to carrying this further to final conclusion, for adoption in the Manual. As an expression of your wishes in that matter I will entertain a motion.

Mr. L. S. Rose (Peoria & Eastern):—I did not understand that is what we want.

Chairman J. E. Teal:—I might say that the Committee has considered this question very seriously. It has debated the thought as to whether or not we were ready to offer it for Manual material at this time. After very careful examination we have decided that it cannot be further abridged. It may be edited, but it would be impossible to further abridge this material and get the full benefit from this report.

Mr. M. F. Mannion:—The motion I made was that this be adopted for inclusion in the Manual.

Past-President Louis Yager:—The Committee very definitely puts itself on record in the published pages that this was to be considered for final preparation. Now they have come before you with a definite recommendation that this material be accepted as it is, for publication in the Manual, with such editing as may be found necessary. That puts it to a discussion of the merits of the subject-matter.

Mr. Frank Ringer (Missouri–Kansas–Texas):—I would like to ask if the Committee is willing to have the convention accept this, in view of the importance and the length at which this subject has been presented as information, with a view to submitting it for final adoption at the convention a year from this time.

Past-President Louis Yager:—Your comments, Mr. Ringer, go back to a reconsideration of their original motion in the matter.

Mr. M. F. Mannion:—As Mr. Teal stated, we have given this matter very careful consideration. As you stated yourself, this Committee has been working on this subject for the last seven or eight years. We spent consider-

able time last year, and even prior to that, in getting all of this information arranged in shape and condensing it to the greatest possible degree. The entire Committee has felt that any modification of this report would tend to reduce its value. Of course, we do not say that there might not be a rewording of a term here or there, but any such rewording would not tend to increase the value of the report or the ideas which are brought out in the report. That is the reason we made this recommendation at this time. We feel that there should be in the Manual some of the work of this Committee which has been going on for the last eight years, as the conclusions which they have found are of value to the Association.

Past-President Louis Yager:—Without appearing to be argumentative and taking the privilege of the position of the Chair, I think I will take the liberty of elaborating somewhat on Mr. Ringer's ideas. It is probably undoubtedly true that a good many of you came to the convention, having read this report and having found at the conclusion of the report that the Committee has submitted this for consideration and information and future study. Now the Committee comes before you and changes that recommendation to final adoption.

In view of that, it seems to the Chair that it is incumbent upon the Committee to give you the reasons for their change in point of view. That does not go to the subject matter of the importance of this report. That is well acknowledged. It is one of the finest pieces of work that any Committee has presented to you in a number of years' work. Is there any further discussion?

Mr. W. P. Wiltsee (Norfolk & Western):—This is a very important report. I think it is very well gotten up and one of the finest reports we have had presented to this convention. At the same time we must guard the information that goes into our Manual It has always been the practice heretofore to submit information on new subjects such as this for a year for consideration and then submit them for inclusion in the Manual.

I do not think it would detract any from the value of this report to let it run over a year and give us who have not seen it before, at least a year to consider it.

Mr. Frank Ringer:—Mr. Wiltsee has expressed my views exactly. It has been the custom generally, in presenting specifications and other matter suggested for publication in the Manual, to have it introduced as information. I, and I dare say others, have not had the opportunity to study this very valuable report. I am in favor of seeing it published in the Proceedings and offered for inclusion in the Manual a year from this time.

Mr. A. F. Blaess (Illinois Central):—I should like to endorse what the previous speaker has said. It has taken the Committee eight years to work up this information and they have made a very excellent report, a valuable one. I believe we should have a year for the members of the Association to have more time to study this and analyze it than has been given them since the Bulletin was published. It ought to be carried over another year before it is published.

Mr. W. J. Burton (Missouri Pacific):—It seems to me it is a new idea for us to accept for inclusion in the Manual a report which requires editing. We have always as far as I can remember insisted that the material for the Manual be presented in its final shape and be acted on in that way. The argument advanced that we need this information right away does not apply because it has

already been presented to us. We can read it just as well out of the Bulletin as we can out of the Manual. So I hope that this Committee can see fit to hold it another year and put it in final shape.

Mr. L. S. Rose:—I would like to say that all of this has been here before. This is not new. There is not anything new in the report. Everybody who has had a desire to read it over has had plenty of opportunity. I do not think anyone who has put it off heretofore will take it up this year.

Mr. C. W. Baldridge (Atchison, Topeka & Santa Fe):—If we want to be technical we might go to the Constitution, which reads: General Rules for Publication in the Manual, Article 4, sub-heading "Contents" reads as follows: "The Manual will only include conclusions relating to definitions, specifications and principles of practice as have been made the subject of special study by a Standing or Special Committee and embodied in a Committee report, published not less than 30 days prior to the Annual Convention, and submitted by the Committee to the Annual Convention, and which, after due consideration and discussion, shall have been voted on and formally adopted by the Association."

I do not believe this report has been published for 30 days.

Chairman J. E. Teal:—I believe that is a fact, that this report was late in getting out. I am not in position to say that this Committee is responsible for the tardiness of the report. I do want to say this, that this is an Economics Committee and we know that it costs money to publish reports. There are several pages of this report and it would cost considerable to bring it up again next year. We desire to save money.

Mr. Frank Ringer:—In order to get the matter before the convention, I move that this report be received as information.

Past-President Louis Yager:—There is already a motion before the house.

Mr. Frank Ringer:—I move to amend the motion that the report instead of being published in the Manual be received as information at this time.

Past-President Louis Yager:—It has been moved and seconded that the report under discussion be received as information. Is there any discussion? If not, those in favor of the amendment which is to the effect that this report be received as information, signify by saying "aye"; contrary, "no." The amendment prevails.

Chairman J. E. Teal:—Report covering Assignment 3, Appendix B, will be presented by Mr. Hastings, Chairman of the Sub-Committee. The report is found on page 693.

Mr. E. M. Hastings (Richmond, Fredericksburg & Potomac):—I hope you will treat this short report more gently than you did the long one. Your Committee this year reports a conclusion including a short formula in the nature of a form, and two pages of notes to be used in connection with that formula. It is a bringing together in very concise form material which was studied for, I believe, about two years by a Sub-Committee of this Committee, and was last year presented to you as information in an Appendix which you will find on page 1014 of Volume 31. It was quite a lengthy paper. This boils it down for you, and we feel is in shape for the Manual. It is a formula for determining comparative economies of flat and hump yard switching.

I move that this conclusion with the form and notes in connection therewith, found on pages 693 to 696, inclusive, be received for publication in the Manual.

Past-President Louis Yager:—You have heard the motion which has been duly seconded, that the material appearing under Appendix B be received for publication in the Manual. Is there any discussion? If not, those in favor signify by saying "aye"; contrary, "no." It is carried.

Chairman J. E. Teal:—Report covering Assignment 5, Appendix C, found on page 697, will be presented by Mr. Howe, Chairman of the Sub-Committee.

Mr. C. H. R. Howe (Chesapeake & Ohio):—This report is even shorter than Mr. Hastings'. The report now being presented is a brief résumé of the reports and discussions previously published by this Committee in the Proceedings of the Association.

The object of the assignment is readily apparent and the purpose to be served is obvious. In the process of any cost comparison, we submit that there are three factors or elements which must be considered, namely, first, results in terms of basic units; second, comparison of details in terms of subsidiary units; third, explanatory statement of conditions.

As to the cost in terms of basic units, these are in fact statements of results or effect. The actual comparisons must be obtained through the study of the causes that produce the effect. To make such studies it is necessary to segregate the primary accounts into their component sub-accounts applying such further identifying units, or combination of units peculiar to the item under consideration, as are essential to the analysis.

Valuable as such data may be, any comparison is apt to be misleading unless a thorough understanding is had of all the attendant conditions of operation, of maintenance of equipment, and of maintenance of way.

Your Committee finds that the basic units of comparison are very definitely established by custom and general use. They are as follows:

Freight Service, both rail and water
- Gross Ton Mile
- Net Ton Mile
- Revenue Ton Mile

Passenger Service
- Gross Ton Mile—both rail and water
- Passenger Car Mile—Rail
- Revenue Passenger Mile—Water

In regard to subsidiary units, your Committee is of the opinion that the choice of units necessary for individual account analysis is largely governed by the conditions imposed by the particular problem in question. Such units, and combinations of units, are numerous and of varying importance, and to publish a list showing their application to the individual accounts would serve no useful purpose, as it would be a repetition of subject-matter already presented to the Association in the report of this Committee with necessary explanations and submitted in the Proceedings, Volume 28, pages 514 to 524 inclusive.

The report is submitted as information, with the recommendation that the subject be discontinued.

Past-President Louis Yager:—If there are no objections or questions, the report will be submitted as information and the Committee on Outline of Work will note the Committee's recommendations.

Chairman J. E. Teal:—Report covering Assignment 6, Appendix D, found on page 699, will be presented by Mr. Steinberger, Chairman of the Sub-Committee.

Mr. M. F. Steinberger (Baltimore & Ohio):—Inasmuch as this report takes only about a page, or slightly over, probably the simple thing to do would be to read it as it appears on page 699.

(Mr. M. F. Steinberger read Appendix D, pages 699 and 700 of Bulletin No. 334.)

Past-President Louis Yager:—Are there any questions? If not, this will be received as information and the Committee on Outline of Work will give consideration to the question of possible duplication of the Motor Transport Division.

Chairman J. E. Teal:—Report covering Assignment 9, Appendix E, is found on page 700. This assignment was study and report on economies resulting from the use of the radio telephone for long freight trains and for yard work.

The subject was covered in a report of some length last year, and it will be found as Appendix H on page 1027 in Volume 31 of the Proceedings, the concluding paragraph indicating that the development of radio service in connection with freight train operation was progressing rapidly but that doubtless the Federal Radio Commission would probably restrict its adaptability because of the very limited number of radio frequencies available for use in this country, and the large demand for frequencies from such service as aviation, police, television and ships at sea. It seems problematical that the Federal Radio Commission will issue permits for general use for retarder yard or train service.

This Committee has not been able to obtain any further information as to the use of the radio in yard and train service, and as far as we know the Federal Radio Commission will only give experimental permits. We have learned, however, that the Radio Commission would give permits for the use of radio between land stations and tug boats in harbor work, and so on, and that if the railway applicant finds its use is a public convenience the Radio Commission will probably issue permanent permits for such service.

The Committee recommends that this report be received as information only, and that the subject be discontinued.

Past-President Louis Yager:—Are there any questions? If not, it will be received as information and the Outline of Work Committee will give consideration to the suggestion of the Committee.

This concludes the work of this Committee, and they are dismissed with the thanks of the Association for their very instructive, interesting report, as well as their stimulating effort (Applause).

■

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